

COMMERCIALIZATION OF ACADEMIC BIOMEDICAL RESEARCH

HEARINGS
BEFORE THE
SUBCOMMITTEE ON
INVESTIGATIONS AND OVERSIGHT
AND THE
SUBCOMMITTEE ON
SCIENCE, RESEARCH AND TECHNOLOGY
OF THE
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COMMERCIALIZATION OF ACADEMIC BIOMEDICAL RESEARCH

MONDAY, JUNE 8, 1981

HOUSE OF REPRESENTATIVES, COMMITTEE ON SCIENCE AND
TECHNOLOGY, SUBCOMMITTEE ON INVESTIGATIONS AND
OVERSIGHT, AND THE SUBCOMMITTEE ON SCIENCE, RE-
SEARCH AND TECHNOLOGY,

Washington, D.C.

The joint hearing met, pursuant to call, at 1 p.m., in room 2325, Rayburn House Office Building, Hon. Albert Gore, Jr. (chairman of the Subcommittee on Investigations and Oversight) presiding.

Mr. GORE. The subcommittee will come to order.

Now that the debate over the safety of conducting recombinant DNA, or "genetic" research has subsided a bit, a new set of concerns has pushed its way into scientific and public debates.

The concern arises from a new, widely shared realization of the vast commercial potential of genetic technologies, and focuses in part on what role universities and their faculties will have in this commercialization process.

Because this subcommittee is conducting a series of hearings on current ethical and institutional considerations in biomedical research, we along with my colleague Doug Walgren, chairman of the Subcommittee on Science, Research, and Technology, have turned our attention to this issue.

We are all certainly aware of the debate that was ignited last fall when Harvard University announced its intention to participate in a corporation to market genetic products produced in the university's laboratories.

The idea, which was labeled "Harvard, Inc." by one newspaper, conjured up two very different images: Opponents envisioned prestigious biomedical investigators commandeering Federal research money and graduate students and hitting it big on the stock market with the open traditions of academic research left behind in shambles.

The other viewpoint suggested that university administrators, faced with inflation and dwindling outside support of basic biomedical research, were wisely trying to gain a financial return on a substantial university investment in basic research.

In any event, the movement toward research institutions' involvement in commercializing genetic technologies appears to be continuing. Just recently, Massachusetts General Hospital announced an agreement to do basic genetic research for a German chemical firm in exchange for some \$50 million.

If these trends are to continue, they certainly warrant discussion of some crucial questions:

First, what impact will involvement in commercialization have on the university research climate? At one leading biomedical university two faculty investigators with offices along the same hallway are also leading figures in competing commercial genetic firms.

We need to evaluate the impact of commercial involvement on how basic research priorities are developed, and how resources are allocated. Another important question is whether the free exchange of knowledge will be adversely affected.

Some critics note that biomedical conferences are now sprinkled with lawyers and commercial representatives, to remind investigators that financial returns may depend upon secrecy.

Second, with the remarkable commercial potential of genetic products, who is entitled to the financial return?

Is it the investigator, the university, or the business firm?

Because the public has been the major supporter of basic biomedical research for some time, what should its return be, and what form should it take?

In Massachusetts, for example, is a foreign chemical company skimming the cream produced by decades of taxpayer funded work?

Third, if we establish that there might be problems with university involvement, what mechanisms are available to protect the interest of the university?

The next 2 days will give us some emerging models, such as commercial middlemen and private foundations, which might act as buffers against negative impacts to the university climate.

Fourth, how does biomedical research compare to other disciplines, where university-industry relationships have existed for some time?

Some observers have suggested that biomedicine is merely going through the pains of having its first commercially valuable products and that only the peculiar ethical and commercial portent of genetics makes it noticeable.

Most of us are aware of the "Silicon Valley" phenomenon, where a network of electronic firms emerged with Stanford University as a nucleus.

The pharmaceutical industry continues to have relationships with research institutions.

It will be useful to compare the commercialization of genetic research with the experience in older fields where universities are old news and examine how the ethical and institutional problems of university-industry relationships have been handled.

Fifth, it is important to examine commercialization in light of existing mechanisms for commercialization. We will hear now an institution like MIT has in place a plethora of commercial arrangements to develop technologies out of basic research, ranging from relatively benign patent utilization programs to research done under specific sponsorship by a commercial interest.

We need to know to what extent the recent events in genetics are just "commercialization as usual" and to what degrees they represent a departure from existing mechanisms to commercialize research.

Lastly, it is important that we address the issue of guidelines. Is it necessary for universities to develop codes of ethics for faculty members?

What guidance, if any, do universities need from the Federal Government?

Although the subcommittee is skeptical about the need for new regulations, we should ask whether universities need to know more clearly how the Government interprets university-industry relationships in terms of tax status, to cite only one example.

Over the next 2 days, we will hear from some leading academic spokesmen, commercial representatives and Government officials on these and other issues.

We hope that this will be a healthy forum for discussion of this very timely issue, and that our hearing record will serve as a source to the major scientific deliberative bodies, including the National Academy of Sciences, that will be considering this issue in the coming months.

I would lastly like to announce that the subcommittee has asked the Office of Technology Assessment to assist us in an overall review of this subject of biocommerce.

We are hopeful that their work, coupled with the record of the next 2 days will contribute toward an honest resolution of these difficult issues.

I am pleased to be cochairing this proceeding with Doug Walgren, chairman of the Subcommittee on Science, Research and Technology, whom I now recognize.

Mr. WALGREN. Thank you, Mr. Chairman.

We do have two subcommittees of the Science and Technology Committee that are especially interested in this subject, and we hope by bringing our interest to it that we will play a role in broadening the discussion of the issue itself.

The Subcommittee on Science, Research and Technology has had an ongoing interest in genetic research and has been concerned for 10 years with various issues surrounding it.

The subcommittee's most recent report was published last August. Over the past few years there has been extensive congressional interest in genetic research. Four different committees of the House and Senate have held hearings or considered bills on recombinant DNA research.

We have addressed the issues of regulation, safety, ethics, and public policy of genetic research. Now developments bring us to other issues: economics and university-industry relations.

The explosive developments in university-based genetic research—and in related microbiological research—over the past decade are being snatched up for use in commercial products and processes.

On the one hand this is to be welcomed; there is enormous potential in biotechnology for improving the well-being of all people and the health of the U.S. economy.

On the other hand, commercial development may be damaging—either to the environment or to national institutions, including universities.

With inflation and a drastic reduction in Federal support, universities are having unprecedented economic problems and are looking with great interests to alternative sources for funds.

Research in biotechnologies—the extraordinary advances in genetics, medicine, and other biological sciences—has the potential to make money for universities.

Yet the suggestion of universities joining in commercial ventures is viewed by some with skepticism. Universities stand for independence of thought, freedom of inquiry, and a free exchange of ideas. Any suggestion of change in the academic environment causes apprehension and concern. These issues need to be discussed.

The idea, however, of industries and universities having ties is not a new one. Beneficial liaisons between the two have existed in physics and chemistry. But there are differences between what happened then and what is happening now in their relationship.

Traditionally, basic and applied sciences have been separated. Scientists in the two areas approach research from entirely different angles. Also, discoveries pass through stages: from the basic scientist to the applied scientists and then to industry.

What happened in laser technology is an example. At the start, the basic scientists invented the laser. It was just considered a laboratory novelty for several years until the applied scientists saw the potential for its use and engineered the laser for application in numerous areas, such as in intricate surgery on the eye or in cutting cloth.

Then, industry, seeing a potential market in medicine or the garment industry, started commercially producing the laser. It would have been difficult or impossible for the basic scientists to translate his research quickly into a marketable product.

But now in genetic engineering, there seems to be no phase of applied research: the discovery of the basic scientists may go directly and swiftly from the laboratory bench in the university into a profitmaking venture.

Many institutional and ethical issues surface when basic research efforts in universities may immediately become highly profitable.

For example, will research in the basic sciences and teaching curricula be affected? If so, is this to be feared or welcomed? Will scientists and students be attracted to money and applied research? If so, will this be good or bad for basic research?

Will involvement with industry change the criteria for academic promotions and new appointments?

Will the tax-free status of the university be affected?

What is the role of the State and Federal Governments in a situation where a State university is involved in industry?

What are the patent rights of the scientist, university, and industry in a joint commercial venture?

There is a positive side to an alliance between industry and academic science. It could lead to a new relationship and better understanding between them. Together they could share talents, ideas, and even profits. Perhaps such an alliance is the first step toward financial independence for universities. They no longer would be obligated to the Government for funds.

We will be hearing from witnesses with views from academia, business, and the Government. We wish to provide an open forum in which we may learn and discuss these issues.

We hope these hearings will provide insights on how Congress, the administration, universities, and industries may work together to resolve the issues.

Our subcommittee will be very pleased to hear comments from Mr. Shamansky and Mr. Brown at the appropriate time. I know they will be interested in making their contributions.

As I said at the beginning of my remarks, I am looking forward to the testimony. And I want particularly to recognize the role of Chairman Gore of the Investigations and Oversight Subcommittee in focusing the attention of the full committee on this important subject.

Mr. GORE. Thank you very much. Without objection, a statement by Hon. Margaret Heckler will be included in the record at this point.

[The opening statement of Mrs. Heckler follows:]

OPENING REMARKS OF HON. MARGARET HECKLER

I am delighted to be here this afternoon to participate in these hearings on the role of the university in commercializing university genetic research. I would like to congratulate Chairman Walgren and Chairman Gore for their foresight in setting up these hearings.

Biotechnology has become the umbrella term to describe all facets of genetic engineering, be it the relatively simple and long-known methods of plant breeding begun by the Moravian Monk Gregor Mendel in the mid-1800's, or the more complex issue of actually manipulating genetic material as in the case of recombinant DNA.

My experience on the Agriculture Committee has familiarized me with the enormous potential for genetic engineering in agriculture. Current work in biological nitrogen fixation, exploitation of symbiotic relationships between crops and microorganisms in the soil, breeding for plant resistance to environmental stress, and other areas is showing great promise.

There is equal, if not greater potential in the manipulation of the genetic material itself. Advances in cell fusion, nuclear transplantation, and particularly, recombinant DNA techniques have recently lead to the production of human insulin, growth hormones, and interferon.

The issue before us today comes as a result of the great promise these recent developments incur; the great commercial promise to be specific. So great is this promise that many universities would like to benefit from the substantial profits to be made from potential research results.

Unfortunately, the seemingly simple process of the university sitting back and collecting profits, in whatever form, from various faculty research endeavors in the biotechnology field is very complex in its execution. Recent experience at Harvard bears this point out.

I look forward to these two days of hearings because I am anxious to hear these issues discussed by both the universities and the private sector. I must say I am pleased that two of Massachusetts' finest institutions are represented.

Today we will hear from Dr. Paul Gray, President of MIT, and tomorrow we will hear from Harvard's general counsel, Daniel Steiner. I look forward to their testimony.

While I am skeptical of the appropriateness of Federal involvement in what appears to be an issue better handled at the university level and among the various professional organizations, I am most anxious to see the discussion proceed.

Thank you Mr. Chairman.

Mr. GORE. Without objection, recording devices and photographic devices will be allowed during these hearings.

Our first witness is Donald Kennedy of Stanford University. We are pleased to have you here. You are appearing as president of Stanford and also on behalf of the Association of American Univer-

sities and the National Association of State Universities and Land Grant Colleges.

Of course, we know you well in part because you used to head the Food and Drug Administration from 1977 to 1979. The record should reflect that you have been a leading spokesman on the issue of commercializing genetic research and we are very honored and pleased you can lead off our hearings today.

Without objection, the entire text of your statement will be included in the record and we invite you to proceed with your presentation in all or in part as you see fit.

**STATEMENT OF DR. DONALD KENNEDY, PRESIDENT,
STANFORD UNIVERSITY, STANFORD, CALIF.**

Dr. KENNEDY. Thank you very much, Mr. Chairman. I am sure your colleagues will be grateful if I choose the second of the two options you have offered me and simply hit the high spots so we can have more time for discussing these matters.

Let me begin by trying to make the point that the revolutionary developments in biological technology that have brought us to this point are simply harbingers of similar problems we are going to find in other areas and perhaps not even only in science areas.

The fact of the matter is that what we have seen in the new thrust to commercialization in genetic research reflects, I think, the drawing of a line between basic and applied research in a new place in terms of commercial interest in it.

I believe that phenomenon is going to stay with us. I think it is important that the subcommittee has chosen to examine this question—both subcommittees—as a kind of model for an inquiry that will surely take us into other zones later on.

I do believe the situation we face now in biological technology is a little different from ones we have seen in the historical development of other major areas of interface between the academic and the industrial world.

The pattern involves the maturation of a scientific discipline to a point where there is a ready transfer between basic research and applications that flow from it. The usual pattern, the Silicon Valley example to which you alluded yourself, Mr. Chairman, in your own introductory remarks, involves a series of spinoffs or related enterprises that function essentially to carry new developments from the basic research laboratory to the point of application.

By and large, university laboratories are not well equipped to carry out that function, and intermediate institutions are extremely valuable in helping to reduce the time for technology transfer.

I know that my colleague, President Gray of MIT, will be talking about some kinds of institutional inventions that he and his colleagues have been involved in that accomplish similar things.

But there is an important difference and the difference I think is this: that in the new style of capitalization of the small commercial enterprises that are now dotting the landscape and that are carrying much of the work in the new genetic technology, there is enormous value attached to the possession of basic intellectual property because there is enormous leverage in the financial changes through successive generations of investment.

As a consequence there is a much more intense corporate interest in the basic research process itself and in the scientists who are responsible for accomplishing that process. You can't look at the prospectus of a single one of these firms without seeing prominent space given to the listing of academic scientists who have accepted some form of affiliation.

Nor is that affiliation typically in the form of the traditional fee-for-service consultant. Instead, it usually involves equity participation in some form or another, and what often results is the splitting up of the research enterprise of a particular academic investigator into a component that is taking place off the campus and is perhaps only distantly related to that taking place on campus.

So two different kinds of things, Mr. Chairman, it seems to me, make the new biotechnology a harbinger of problems we are going to face in the future.

One is the interest on the part of commercial interests in basic research and the second is the scientific maturation that has put this biometric research in a position to begin to contribute swiftly and significantly to the stream of products and ideas and processes in commerce.

I think the new situation affords us some opportunities and some problems, and I have listed these at some length in my testimony. I will only summarize them here.

First, the opportunities. No sponsor for the future of a major research university in this country, whether private or public, can fail to note that there are some portents in the economy that make one a little nervous.

The Government has so far, I think, been reasonably steadfast in its support of the basic research enterprises in universities but in real value it has not moved ahead at anything like the rate it did in the sixties or even in the seventies, and now we face the prospect of real losses year by year in the real value of support.

So understandably those of us who have that responsibility are looking elsewhere, to the private sector as we have been urged to do, for other kinds of support, and this is a natural candidate. None of us can avoid that obvious prospect.

Second, it is obviously in the national interest to try to generate new institutions that are potentially capable of reducing that time-lag between advances made in the basic research laboratory and applications in human service. Every analysis that has been done about the role of basic research in some important applied discipline has emphasized that, and I would call the members' attention to the study by Comroe & Dripps quoted extensively in the report of the President's Commission on Medical Research 5 years ago which shows the diffusion of new innovations in biomedicine from research laboratory to their application in practice is very long, often 10 or 15 years or more, and it would clearly be of great advantage if that time could be reduced.

So there is reason to want to work for a better arrangement. What about the problems? We think that without additional provisions there is going to be a strong tendency for the association of commercial interest with basic science to take the form it is now taking in genetic research, that is, an increasing involvement of

the university faculty members in outside affiliations with particular companies.

There are two problems with that. First, the prospect there will be some contamination of the basic research enterprise in the university by the introduction of a set of new values and new objectives. It is a little hard to evaluate that.

I think a more serious problem is the prospect of a fairly sharp disassociation between research as it takes place in the laboratory, wherever that is, and research training which has always been very closely affiliated with it in the university and which is likely not to be affiliated with it if it takes place in an industrial setting.

One of the great strengths of the system of basic research that has been constructed in the major universities in this country with very strong cooperation from the Congress is the combination of the doing of research and of the training of young scientists in the doing of research.

No enterprise can succeed well with only journeymen and no apprentices, and the next generation of science surely can't be done without tomorrow's journeymen. So that is an important function, and we are reluctant to see it dissected apart.

Third, the commercial environment is obviously characterized by many more proprietary constraints on the openness and accessibility of scientific and technical information, and that troubles us because it seems to me one of the great signs of health in basic research has been not merely the openness of traditional scientific publications, the fundamental law of which is that you say enough about what you have done so that anybody else can repeat your experiment, it is confirmation and verification that the enterprise lives on, and open communication is an absolute bedrock value in that kind of system.

But it also depends, as I think Dr. Patricia Woolf testified in an earlier hearing before you on a different subject, on a kind of informal network of communication in which people trust one another to say a little bit more than they have already published about what is going. That gets a lot of waste out of the system and allows people to move ahead more quickly.

We are already seeing that kind of openness fall into serious jeopardy, and I think we are now beginning even to see threats against the traditional modes of scientific publication and communication.

I have been comparing notes with others and there are at least three or four incidents during this past year in which at scientific meetings—at which the traditional valuation of basic research had always been expected to prevail—there were communications in which a scientist actually refused on questioning to divulge some detail of technique, claiming that, in fact, it was a proprietary matter and that he was not free to communicate it.

If you are not free to communicate it, then somebody else can't repeat your experiment, and whatever enterprise you are involved in it is not the one that traditionally moves science forward. So I think those are real concerns.

How might we procure the opportunities, the advantages without the liabilities? As you pointed out, Harvard University proposed

and then discarded, I think wisely, an experiment in which it might in effect go into business with its own faculty.

Harvard decided and we certainly agree that there would be too many opportunities for conflict of interest and more misunderstanding of the university's role as allocator of research resources and appointments and so forth if it is also seen to be interested in benefitting from a commercial venture in which some of its faculty members are involved and others perhaps doing equally valuable work intellectually are not involved. The university must be seen as an evenhanded allocator.

The second prospect is that universities can regulate outside research by faculty members closely and carefully. That is possible, but I would urge very, very great care in it because of two risks.

First, consulting for outside firms is a valuable activity. It has always been known to be so in applied research. It probably is in basic research as well as long as it does not go too far. I think we run the risk of inhibiting a very valuable kind of activity if we undertake too quickly regulations that would prohibit the things that we are most troubled about.

The second possibility, of course, is that if university regulation of faculty work on the outside is seen as too stringent or arbitrary it will invite disaffiliation of the faculty member from the institution that wishes to hold him instead of the one that he or she is interested in on the outside. So that clearly is not an attractive prospect.

My own conclusion after looking over this developing landscape as carefully as I can is that the basic research enterprises has grown and prospered well within the university environment, that it is successfully bridged with research training which is a very important activity for the Nation to support along with research and that there are a number of reasons for believing it will not prosper so well in the industrial sector where these other constraints intervene.

There are, furthermore, and I know Paul Gray will have more to say on this subject, examples of successful arrangements between industries and particular institutions that can serve all the values that I am talking about and nevertheless provide opportunities faculty members wish to pursue as scientific workers.

I would hope we could improve the record of such ventures.

Right now private industry contributes only about 3 to 4 percent of the basic research budgets indeed of the total research budgets of the major research universities in this country.

That is awfully small when you consider the degree to which industry uses the products of that work, and I think that one possible conclusion is that we need more incentives to support it.

That is one of the reasons why I have been testifying elsewhere in this town in support of the legislation proposed by Congressmen Shannon and Pickle and Senators Danforth and Bradley which would provide for up front tax credits for industries that choose to contribute to research and development and that would clearly include basic research in the universities.

It seems to me that the activity can best be conserved and best be turned to the advantage of the industrial sector if the research that we recognize is basic is done in the climate that is most

hospitable for it and if industry sees a clear advantage as it has in past instances in making it go there.

Mr. Chairman, I think that summarizes the most important points in my testimony and I would be glad if you or members have questions to ask me.

[The prepared statement of Dr. Kennedy follows:]

Testimony by

Donald Kennedy
President of Stanford University

and on behalf of
Association of American Universities
National Association of State Universities
and Land Grant Colleges

"Commercializing University Biomedical Research:

Ethical and Institutional Impacts"

Mr. Chairman, it is a pleasure for me to appear before the Subcommittee this afternoon, representing Stanford University -- an institution centrally involved in the scientific revolutions in genetics and biochemistry that have brought about the present commercial opportunities in biomedicine. (I speak also for the Association of American Universities and the National Association of State Universities and Land Grant Colleges; these associations represent the majority of research universities in the United States.)

Several forces combine to make this issue a particularly important one at this time. There is, first of all, the dramatic maturation of the basic biomedical sciences -- to a point at which they are now producing, on an almost daily basis, discoveries that invite transfer from the research laboratory to development and application. The capacity to produce specific human proteins by large-scale bacterial fermentation using recombinant DNA techniques and the imminent prospect of human monoclonal antibodies against important human disease antigens are but two examples of this extraordinary potential.

In addition to the power of these new techniques, forces of quite a different kind are at work. Sudden increases in value have come to be associated much more with research ideas in the new biomedical technology than has been customary in earlier scientific developments. In part, this relates to the swiftness with which new research opportunities have developed. But in part also, it is due to a new environment for the capital support of research ventures. As was most dramatically illustrated in the recent public offering of the stock of Genentech, a South San Francisco biomedical firm, very large changes in the value of equity in these new commercial ventures may be associated with successive generations of investment. These changes are based on the perception by investors that valuable intellectual property is held by the growing firm -- property that may eventually be turned into useful and profitable products. The leverage associated with these early investment opportunities is very high, and the prospectus of a typical firm emphasizes affiliations or consultantships with distinguished basic scientists, most of them in universities.

This circumstance has led, in effect, to a new commercial premium on what was previously thought to be "basic" research. As a result, companies are actively seeking the participation of university scientists in commercial ventures; and conversely, many universities are giving fresh consideration to ways of managing new research ideas so as to return some of their value to the enterprise that generated it. Behind this latter effort lie two different motivations. First, many

university administrators are legitimately concerned that affiliation with outside ventures may eventually prove a damaging competitor for limited faculty time and skill. Second, we have seen over the past decade a leveling-off of government support for basic research, and more recently a distinct downturn. The political popularity of reducing federal expenditures, and the evident vulnerability of such "controllable" items in the federal budget as research support, has sent those of us responsible for universities off in search of alternative avenues of help. Among these, support from the commercial sector is an obvious candidate -- one we approach with a mixture of enthusiasm and trepidation.

So, Mr. Chairman, I am pleased, as I am sure my colleagues are, that the Subcommittee has chosen to undertake a prospective examination of this new era in university-industry relations. The commercialization of biomedical research provides an appropriate introduction to the more general problem, but I would emphasize that it is a harbinger of developments in areas of research generally thought to be immune to such considerations. The basic problems -- of the ownership of intellectual property, of academic/commercial conflict of interest, of proprietary secrecy, of the distribution of incremental value from new discoveries, and of the need for speeding technology transfer -- are not new to us, though they demand increased attention. It is also likely that they will reappear in other research contexts. We may even encounter some of them in the humanities, where the increasing significance of continuing education and the prospect of a highly competitive

market place in cable television might even lead to a similar commercialization of basic humanities research!

Against this background, let me set out, in the form of a series of brief statements, some views about the opportunities afforded by the new situation we face, and some of its pitfalls. First, the opportunities:

- o A number of studies on the adoption of biomedical technology (e.g. Julius H. Comroe, Jr. and R. D. Dripps, "Scientific Basis for the Support of Biomedical Science," *Science*, 192 (April 9, 1976), 105-111.) illustrate that the time required for the diffusion of new innovations from the research laboratory to their application in the public interest is often disturbingly long -- ten years or more. It can be argued that the involvement of commercial organizations in basic research will bring applications work closer to primary discovery, and thereby reduce the lag-time from conception to utilization in the stream of commerce.
- o Commercial interest in basic research, whether it involves the attraction of

scientists to industry or increased support of academic work by industry, will add a new and needed source of funding for such work at a time at which it is especially needed.

And now the problems:

- o Without additional provisions, there will be a strong tendency for the association of commercial interest with basic science to take the form it is now taking; that is, an increasing involvement of university faculty members in outside affiliations with particular companies. That prospect presents at least two difficulties. First, there is the prospect of significant contamination of the university's basic research enterprise by the introduction of strong commercial motivations and potential conflicts of interest on the part of faculty members with respect to their obligations to the corporations in which they have consultancies or equity and their obligations to the university. Second, there is the danger of a sharp

dissociation between research -- as it moves more into industrial settings -- and research training, which has always been a critical obligation of the universities and which industry is unequipped to do.

- o The commercial environment is characterized by many more constraints upon the openness and accessibility of scientific and technical information than is the university environment. Proprietary restraints on the free exchange of data have already begun to crop up at biomedical research meetings, and are presenting challenges to the policies of scientific societies and journals accustomed to open publication. Even more damage has been done to the informal roots of communication that characterize most vigorous fields of basic biological research.

Mr. Chairman, given that it would be in the interest of both the universities and the Nation to procure the benefits I have outlined, how might we manage to control these liabilities?

One of the proposed solutions is that the universities go into business directly with their own faculties, thereby keeping the venture at home and avoiding the risks of dissociating the research enterprise. Such a proposal has recently been carefully considered by Harvard University, and rejected. President Bok's annual report to the Harvard Board of Overseers sets out carefully and thoroughly the grounds for that rejection. We have given similar consideration to the problem at Stanford, and reached a similar conclusion. Our faculty Committee on Research has recently voted overwhelmingly to reject equity participation on the part of the University in faculty research ventures.

What other solutions are open to us? One, clearly, is for the universities to regulate the participation of their own faculty members in such outside ventures. But that approach entails several difficulties. First, industry consulting of various kinds has proven valuable in a number of other research sectors in the university, and long standing policy and tradition permits it. If we unwisely attempt to prevent the prospective injury associated with outside commitments to these new ventures, we may find ourselves suppressing valuable kinds of associations. There is, in addition, the danger that if the universities overregulate faculty behavior those faculty members will end their affiliations with the university instead of with the outside ventures.

That would indeed be damaging. The research universities of this country -- in a partnership with government that has developed over several decades of careful congressional consideration, by this committee among others -- have become a truly remarkable resource. They accomplish over two-thirds of the basic research done in the United States, and the scientists who do it collectively dominate not only the national scientific enterprise but that of the entire world. This basic research system is characterized by a mixture of independent investigation and research training, and is characterized by an unusually open system of information exchange. For these reasons, it would seem to be in the national interest to keep the line between basic and applied research about where it is. If we are to do that, then it seems we must find a way to increase the rather small proportion of industry contribution to university research (it is less than 5% at Stanford, and averages only about 3 1/2% for the research universities of the United States) without launching a migration of the universities' best research talent out into industry.

I cannot avoid the conclusion that the right approach is an increase in the incentives offered for industrial investment in university research programs. That approach would have the advantage of keeping the effective basic research organizations of universities intact; yet it would allow, through the making of specific affiliation and licensing agreements, industrial organizations to realize some longer ranged benefits from those investments. A few successful examples of such agreements are already at hand. They are not easy to work out,

but that is not the only reason for their scarcity. In our view, there should be further financial incentives for the taking of what is, after all, an investment that carries considerable risk. We think that the legislation offered by Congressman Shannon and others, as H.R. 3288, is an appropriate vehicle for this kind of incentive. As you know, Mr. Chairman, this important bill permits industry to receive tax credits for sponsoring basic research at universities, and thus in a single stroke provides the multiple advantages of ---

- o furnishing industry with a new incentive to invest in basic research which it is frequently incapable of conducting itself,
- o significantly invigorating the relationship between industry and universities without some of the hazards I see in the present helter-skelter pattern of affiliation that we see today, and
- o as a critical by product, training scientists and engineers more attuned to the needs of industry.

I believe, in summary, that basic research in universities needs more, not less, relationship to industry. But I believe the conditions for that relationship need to be

I believe the conditions for that relationship need to be carefully structured, if a highly evolved and highly efficient mechanism for doing basic scientific work is not to be unwittingly damaged.

Here I would warn not only against hasty regulatory reactions by the universities, but by Government too. Imposed solutions are not likely to serve us well; the wisest course will entail the structuring of incentives and the exercise of thoughtful oversight. The enterprise we have built is a fragile one. I am grateful for the opportunity to present these views to the Subcommittee, and I invite any questions you or other members may have.

Mr. GORE. Thank you very much.

I think it might be wise for us to follow the 5-minute rule since we have several members here. I will recognize first my colleague Mr. Walgren.

Mr. WALGREN. I would like first to turn to the ranking minority member on our subcommittee for any comments she would like to make.

Mrs. HECKLER. I will wait. Thank you, Mr. Chairman.

Mr. WALGREN. I guess I will withhold at this point, Mr. Chairman.

Mr. GORE. Mrs. Heckler.

Mrs. HECKLER. I have a rather philosophical question for Dr. Kennedy. Who is entitled to the potential returns derived from biotechnical advances: the individual investigator, the university that subsidized him, or the company that brings the technology on line?

Should there be something returned to the Federal Government for providing the majority of support for biomedical research in the last 25 years?

Dr. KENNEDY. Thank you for the opportunity to deal with that question. I think the answer is all of the above. Right now the situation in most cases is that universities, investigators and the public—and sometimes private enterprises—are partners in the support of a research venture. The investigator, because he or she is putting talents and energy into the work; the university because it is providing some of the funding and the space and the intellectual environment; the public because the Government is putting some funding into it, and also because often private funding has been added to the mix, although, as I have said, a little less than we would now like to see.

Right now what normally happens in our institution, at least, is that, if there is a potentially valuable discovery, the investigator who has the rights to the patent under our policy, although this is not true in all institutions, will often assign the patent to the

university or the patent and licensing office will undertake to obtain the patent and to license it.

Our policy is to license it nonexclusively where possible, exclusively only where necessary and desirable to bring things on line as quickly as possible but I think under those circumstances nearly everybody benefits.

The difficulty is when a basic research idea that is had, we will say, by a university investigator, in the context of the fraction of that person's work that is done with the private firm, gets out there. We have then a situation in which the entire value is returned to the private firm, and none of it is shared, or little of it, is shared by the other participants in the process that has brought that investigator to the stage of readiness for that idea and has contributed to the germination of the idea and the birth of whatever it has given rise to.

Mrs. HECKLER. Dr. Kennedy, have you experienced a serious loss of faculty members to commercial ventures as a result of research salaries becoming so valuable that technical professionals are no longer going to remain in the university?

Dr. KENNEDY. We have not. What we are experiencing now is an event whose future is a little difficult to trace. A large number of our faculty members, perhaps 2 dozen or more, have recently concluded or are now contemplating individual arrangements with mostly young, new biotechnology firms.

Those arrangements are on a variety of different bases, some of them involve fee-for-service, more of them involve equity participation, and some involve even quite heavy involvement in research work in the company.

What we are going to have to measure over the next few years is how much of a real loss is experienced in terms of fractional faculty time and energy committed to the research enterprise and to the research training in the university.

We are not losing whole people. What we are concerned about is what the ultimate landscape will look like in terms of the loss of parts of people.

Mrs. HECKLER. You appear to be saying that there is enough time for the university to evolve its own code of ethics but that seems to contradict what we see as the growing commercialization of research and the involvement of professors with very distinguished academic backgrounds in equity participation which are part time now, but will eventually become full time.

That suggests that the process is not really trotting along but is perhaps, galloping.

Is the academic world ready to accelerate its pace in terms of dealing with the ethical questions?

Dr. KENNEDY. That is a very interesting question. I think things are happening quite rapidly all right. I think the gait is fairly characterized as a gallop. Whether we are moving fast enough depends a lot on what part of the problem we as universities can successfully deal with. Because of the nature of the research enterprise in a complex, fast-moving, active, successful field like this one is, there are a lot of actors in it. There are journals, scientific societies, the invisible college of those scientists at different institutions around the country.

The openness of the processes of communication, the degree to which the process of publication and sharing of information at scientific meetings is open and meets the traditional standards of science is one that no single university can decide as a policy matter.

That depends rather on some consensual judgments made by the people who are participating in the enterprises.

In an incident to which I referred earlier where a research worker at a national scientific meeting refused to reveal an interesting technical detail of an experiment on the grounds it was proprietary information, I suspect that the invisible college will in some way act—I would hope it would—to make that out of bounds behavior at a scientific meeting.

But we are charting a new course here, and how quickly that system will respond is anybody's guess.

I think the universities are examining their part of the problem about as quickly as they can, and I think effectively. But they do not have their hands on the whole problem.

Mrs. HECKLER. Thank you, Mr. Chairman.

Mr. GORE. Mr. Brown.

Mr. BROWN. Dr. Kennedy, on page 4 of your statement you make reference to the interesting possibility that we might have a similar situation developing in the commercialization of basic humanities research.

I am rather interested in that possibility and I wonder if you could elaborate briefly on your own thinking with regard to that statement.

Dr. KENNEDY. I would not want this crystal ball venture to be taken too seriously by anybody, but I think that if you look at the enormous interest there now is in continuing education of all kinds, and if you look at the competitive environment that there already is in cable television and public television of various sorts for serious programing, it strikes me that people who have something to say about history or comparative literature or the nature of human experience may very well find that their particular kind of intellectual property begins to have value and is being contested for in somewhat the same way that knowledge of how to recombine genetic material is being sought after now.

My main point is that once there is a strong commercial interest in intellectual property as opposed to the products of intellectual property one is in a somewhat different game. I think it would be nice if that rather crazy prediction came to pass because it would indicate an interest on the part of people in this country in a subject that I think they need to be more interested in.

Perhaps that is a vain hope, but it does illustrate the point that commercial interest in intellectual property is not necessarily confined to one field of science or even to science as a whole.

Mr. BROWN. Getting to the biotechnology field for a moment, you have commented on the shortening of the time span between basic research and commercialization. You are also quite familiar with the delays that can be interjected into this process through Government regulation.

I am thinking of various kinds of processes. I am just curious as to whether you anticipate that after this splurge of rapid commer-

cialization there may be a counteraction, caused by the regulatory process, which delays products getting to the marketplace.

I have no idea what all of the products are likely to be. There may be for example, efforts to develop a whole new range of biological products for which there has been no approval process.

Have you given any thought to the possibility that the regulatory process might intervene and delay a drug getting to the public? As you know, sometimes a simple drug can take several years to run the hurdle, particularly if it is one involving human health.

Dr. KENNEDY. Those delays are real enough. As you know, Mr. Brown, it is hard to know what special problems the new production of this research will pose. I do know that at the Food and Drug Administration plenty of advanced consideration has been given and is now being given to, for example, the regulatory problems that might be posed by human monoclonal antibodies, and by the various products of that material fermentation using displaced segments of human genetic material.

I do not think that these delays are likely to be exceptional but, of course, many people find even the usual delays unacceptably long.

I think that the real challenge institutionally in the whole area of technology transfer is to reduce those delays that are not related to demonstrations of safety or effectiveness required under law and if you look at the case studies analyzed by Comroe & Dripps in that paper to which I alluded earlier you find most of those cases were before there was anything like the extent of regulatory process that there is today, and still the time between the basic research discovery and the ultimate application were very, very long, so long that even the kinds of regulatory delays that we would be used to today would not add a very large percentage onto them.

I think, irrespective of how long the regulatory delays that society now adds to this diffusion time, there is still a large piece of it that we can think about trying to reduce institutionally and get a considerable amount of help out of that effort.

Mr. BROWN. Thank you.

Mr. GORE. Mr. Shamansky.

Mr. SHAMANSKY. Thank you, Mr. Chairman.

Dr. Kennedy, I happen to be a degree holder from Harvard University albeit it was the law school and I was rather charmed that Harvard would have a significant source of income.

I assume that Mr. Bok didn't go into this thing lightly when it came up and I did understand—I heard you to say that it was just as well that Harvard did not pursue it and your university did not. Rather than dismissing it so quickly I would be grateful if you would point out the nub of the problem and what the considerations were and why you support that.

Dr. KENNEDY. I would be glad to do that. Let me not speak for Harvard, although, like you, I hold a degree and wish them well financially.

I will save my gifts for the university I am working for. I don't want to speak for them because Derek Bok has spoken eloquently in his own annual report which he devoted entirely this year to that subject and it is my understanding that Dan Steiner, Harvard

general counsel, will be testifying before the two subcommittees tomorrow and that he will say it much better than I.

I can speak for our own committee for research which voted the same way on that issue and tell you where I see the problems, at least.

Suppose that Stanford goes into business with an immunologist and a biochemist and a geneticist from its medical school faculty and is a significant equity holder along with those faculty members.

Stanford is also responsible, for example, for allocating new faculty billets to particular departments and for assigning research space and so forth.

If the university is in business with one assistant professor in a department or associate professor in a department and not with another, how can it be seen as a fair allocator of those resources?

It seems to me it will either lean over backward in allocating them away from the people with whom it is commercially engaged or it will run the risk of being seriously misunderstood as an allocator.

I think this is one of those cases in which the appearance of conflict of interest is just about as serious as it could be.

Universities operate on a good deal of faculty trust. Collegiality is important. There are, to be sure, cases in which that is lacking because of competitiveness about research or for other reasons, and some have argued that after all since that is already the case, why worry about exacerbating it? But I do worry about exacerbating it.

I think anything the institution does to increase those differential incentives is likely to be troublesome.

The university, furthermore, does have other ways of returning a reasonable portion of that value. They can engage in the patenting and technology-selling business and so forth on a basis that benefits both the faculty member's individual research program—he who has made the discoveries—and benefits the university more generally, and we have evolved a plan that I think is working very satisfactorily in that way.

You can, of course, return more of the value still if you have a piece of the action but I think the price is too high.

Mr. SHAMANSKY. You also state that basic research at universities needs more, not less, relationship to industry. Let me jump back, I am sorry.

Pursuing this line, who in this process, in your opinion, is entitled to get the potential returns from the biotechnical advances?

To what extent should it be the individual investigator or the university or the company that brings the technology on line?

In your second response you said you could license. What have you evolved as a fair method of allocating these benefits?

Dr. KENNEDY. On returns from licensed patents, Mr. Shamansky, we divide royalty income between the investigator, the investigator's department and the school—school in our terminology is one of the university's seven faculties: medicine, engineering, et cetera—so that the return is split in equal thirds in that fashion.

Mr. SHAMANSKY. The individual would have a chance to benefit from it?

Dr. KENNEDY. That is right. Under our policy the rights to that invention belong to the individual faculty member and not to the university. That is our option. We could change that policy if we wanted to. We don't.

Mr. SHAMANSKY. Thank you, Doctor.

Mr. GORE. Mr. Weber.

Mr. WEBER. I have no questions.

Mr. GORE. Mr. Skeen.

Mr. SKEEN. No questions.

Mr. GORE. Dr. Kennedy, let me ask you a couple questions about the public's investment in genetic research.

The traditional means by which the public recovers its investment is in the form of tax revenues on the new ventures made possible by advances in knowledge.

The link between information and wealth in the field of genetic information is much closer than is normally the case, the distance between the test tube and the cash register, if you will.

It seems to me that the potential for recovering increased tax revenues from new ventures becomes complicated by the technology transfer issue.

I am thinking specifically of the Hoechst agreement with Mass General. Last year the American taxpayers provided \$26.1 million to Mass General for biomedical research. Now there will be evidently an exclusive agreement between Mass General and its new facility and this foreign chemical company to market the results of its research.

If the taxpayers have spent tens of millions—\$26 million last year, and I don't have the figures at my fingertips for the prior years—and then the research gets to the stage where it is ready to produce marketable products, is it wise for us to look the other way after making this investment when a foreign company comes in and skims the cream off the top after the taxpayers have worked for so long to get it to that stage?

Dr. KENNEDY. Mr. Chairman, I can't comment very accurately on the situation because, like you, I have had only access to newspaper accounts along with one rather bizarre telephone inquiry which I won't tax you and your colleagues with.

Mr. GORE. Sounds interesting.

Dr. KENNEDY. You see, the point is, as I understand it from reading about it, the investigator who will lead this program will move to Massachusetts General from an institution in our area, in fact, from the University of California in San Francisco, and this program will in effect then be a new start program.

If that is right, then perhaps the argument about the taxpayers' previous investment which would refer to all of the ongoing publicly supported programs at General would not apply to the new one.

If it can be shown this is an incremental program with new workers depending upon new inputs, in this case of private money, then it would represent in some sense a relief for the taxpayers since here is a vigorous research program being funded entirely privately and that public contribution can continue to flow to it perhaps it has already supported and other new programs.

I would think, however, that a scenario like the one you propose might sometime happen and if it did I would be concerned.

Mr. GORE. Presumably this new director is not going to do it by himself and it seems unreasonable to suppose that all of the people at work in the new facility will be people who have not had an ongoing participation in Mass General's medical activities while they have been taxpayer funded.

It is more likely that there will be an overlap between the two.

Dr. KENNEDY. I just don't know what the arrangements are so I can't really answer the question. You can certainly generalize it and say does not the public, by virtue of its strong investment in the training and in all of the earlier work of most of the investigators who are doing that, own that share quite independent of what institution it happened to be mediating through. I think that is right.

Mr. GORE. You mentioned the tax credit proposal increase in the Senate for private industry to pick up a large share of R. & D. in the university.

What other mechanisms might be used to serve the needs of universities and provide incentive necessary to encourage companies to invest and at the same time protect the research climate?

Dr. KENNEDY. I have not thought exhaustively about the problem. We have looked over as carefully as we can the opportunities for modifying the tax structure to promote that sort of interest and that is the best proposal that we have seen and that is why we are supporting it strongly.

There are others but they really all do involve, I would think, financial incentives. After all, it is a risky business to support basic research. You can do it 9 times and not get much from it and then the 10th time you perhaps do quite well, but it is a long-term investment, and it is one that research managers are sometimes reluctant to make because they understand that their performance is going to be judged on a shorter time constant than that.

Mr. GORE. Well, my time has expired.

Mr. Walgren?

Mr. WALGREN. Thank you, Mr. Chairman.

I wanted to ask, if private industry contributes 3.5 percent or thereabouts of basic research money, what does the public contribute through NSF and perhaps through some other ways?

Mr. KENNEDY. For the major research universities of the country, on the average, if you look at total grant funding, I suppose around 3.5 of the major private foundations might total 10 or 12, the Government probably over 75.

Mr. WALGREN. 75 percent?

Dr. KENNEDY. Yes.

I do not have the figures at my fingertips and probably somebody else in this room knows them by heart and can help me out.

Mr. GORE. I think it is 72 percent.

Dr. KENNEDY. Well, 3 percent error, that is all right, Mr. Chairman, I will stand by it.

Mr. WALGREN. When you consider that the public is contributing 72 percent in the support of the basic research facility out of which all this is growing, it sort of underscores the pervasiveness of the public interest in whatever benefits are derived from this area, doesn't it?

Dr. KENNEDY. Yes, I think so. But you can say that it is a very traditional mechanism here, that the public supports research that we rely on a value-conscious commercial sector to capture those benefits in the form of products and services and that the value increase they experience is their reward for playing that part in the process.

I think it is a complicated public policy question, just what distribution of that last stage increase in value is appropriate. I would emphasize, Mr. Walgren, what I think is novel about the present situation is that basic research done right within the sector where the public support is the traditional mechanism is responsible for these vast increases in value. And that is the new phenomenon, and that is what gives rise to the new set of decisions we have to make about what is a fair allocation of that incremental value.

Mr. WALGREN. I had not really thought about the term pursuit of the almighty dollar with the accent mark on the dollar to the degree that this subject makes me think proper.

It is true, is it not that if a university had an equity interest in a commercial venture this could literally be, in addition to subverting the openness and what not, the driving force of the direction of the university.

Mr. KENNEDY. Yes.

Mr. Walgren, if you knew the number of times that Californians interested in my university have said to me, "Just think, if you guys had gotten only 1 percent of Hewlett-Packard back in the old days."

Mr. WALGREN. Can you explore a bit with us about the code of ethics that Stanford uses with respect to the individual participation of their professors? This is one of the few areas where I find myself sympathetic to the argument, that if a professor had an equity interest in a company which was to benefit substantially, it might affect his behavior and the direction of his own research.

Dr. KENNEDY. Like most universities, Mr. Walgren, we regulate participation of faculty members in outside ventures only on the basis of time spent and not on the basis of nature of activity or compensation. We permit faculty to consult the equivalent of 1 day a week, it is actually 13 days a quarter, but that is what it comes down to, and that is a policy almost identical to that in place at most major research universities in this country.

We do not and have not in the past made any distinction whether that is on a fee-for-service basis or whether it is on the basis of equity participation because at the time the rules were laid down equity participation was sufficiently rare that it wouldn't have been adequate to trigger a regulatory response.

I would call your attention to one or two exceptions to that that have been necessitated by just plain economic realities. At the time when the Nation's medical schools, when their clinical faculties in general went to a system in which clinical faculty members were employed and paid a full salary by the institution, the institution made the regulation that they could not practice on their own outside.

That is the only explicit prohibition I know of against faculty members doing particular kinds of activity for money. And it is

obviously necessitated by the fact that in most medical schools clinical faculties participate in the faculty practice plan, and to have independent practice as well would simply threaten the integrity of that system.

I mention that not only because I think it is an important comparative point for the subcommittees to ponder, but also because I think it raises a question, a new set of questions with respect to what the basic scientists are doing.

If a cardiovascular surgeon who could well do quite a lot transplanting or implanting heart valves on a Saturday is prohibited from doing so, what is the reaction of that surgeon going to be to an extremely successful Saturday venture on the part of a basic scientist which is just as lucrative as the practice of cardiovascular surgery and yet not subject to the particular restriction that traditionally has held with respect to clinical practice?

That is kind of a problem in parallel treatment, I think, and it is one that our faculty members in medicine aren't unaware of.

Mr. WALGREN. Thank you.

Mr. SHAMANSKY. Point of information, I wanted to tell Dr. Kennedy that this publication here says in 1980 the total university spending for basic reserve derived was 76 percent from the Federal Government, which I thought would back up your original statement.

Dr. KENNEDY. I am even more pleased.

Mr. GORE. OK. Thank you very much for appearing here today and for your testimony, Dr. Kennedy, we appreciate it.

Dr. KENNEDY. Thank you, sir.

Mr. GORE. I sure hope your prediction about the humanities comes true quickly. I look forward particularly to developments in economics that are at that level of interest.

Mr. GORE. I would like to call now our second witness, Dr. Paul Gray, president of the Massachusetts Institute of Technology in Cambridge.

Dr. Gray, welcome, we are pleased to have you here today. Without objection, the entire text of your prepared statement will be put into the record and we invite you to proceed with its presentation at this time.

STATEMENT OF DR. PAUL GRAY, PRESIDENT, MASSACHUSETTS INSTITUTE OF TECHNOLOGY, CAMBRIDGE, MASS.

Dr. GRAY. Thank you, Mr. Chairman, Mr. Gore.

Like Dr. Kennedy, I am appearing today on behalf of the Association of American Universities and of the National Association of State Universities and Land Grant Colleges, as well as on behalf of MIT, which is a member of both.

I very much appreciate this opportunity to address the subcommittees on the transfer of biotechnology between the university and industry. I have chosen to structure these remarks broadly, focusing on the general issues of research contracts between universities and industry, and on university patent and licensing policies for technologies developed from such research. I do so primarily because experience at MIT suggests that contract and policy issues in biotechnology are not substantially different from those in other fields.

In my judgment, four fundamental issues must be addressed:

One, the relevance of a proposed line of inquiry to the essential missions of the university and the industry: how to design collaborative programs which maintain balance between the university's pursuit of research as part of the educational process and industry's search for useful knowledge for the development of products, processes, and services.

Two, timeframes for research efforts: How to organize programs which accommodate the different time constants of industry and of universities, where graduate students—and their theses, which at the doctoral level may stretch over several years—are intimately involved with the research effort.

Three, proprietary rights versus openness: how to assure the protection of proprietary information provided by industry while meeting the statutory and ethical requirements of the university, which demand that research serve a broad public good, that it be conducted in an atmosphere of openness and free exchange, and that results be available for distribution on a nonconfidential basis.

Four, patents and copyrights: how to determine methods of licensing that will promote the progress of science and technology, assure that discoveries and inventions are utilized in ways most likely to benefit the public, and provide adequate recognition to inventors and appropriate financial support to the universities.

Let me expand on these last two points.

In the area of publications, we find ourselves continuously attempting to balance the legitimate desire of industry to prevent premature publication in order to protect patent rights, with the equally legitimate needs of the university to encourage the free dissemination of information. Accordingly, while we clearly cannot freeze information developed in the course of the research program, we are willing to delay publication for a reasonable time period to allow the preparation of patent applications and to insure that information proprietary to the company is not inadvertently included in publication.

Likewise, although information developed at MIT during the research program is not proprietary, the Institute will accept proprietary information from the industrial sponsor if it is necessary for the effective conduct of the research, and will use reasonable precautions to protect such information.

Our normal policy with regard to patents is that MIT will retain ownership of all inventions made in the course of sponsored research. However, we will also grant licenses to sponsors on terms to be negotiated.

The basic aim of MIT's licensing policy is to promote the progress of science and technology through the provisions of the patent system, to assure that discoveries and inventions are utilized in ways most likely to benefit the public, and to provide adequate recognition to inventors as well as appropriate royalty revenues to the Institute.

Where feasible, nonexclusive licenses are granted to all qualified marketing efforts. If, in a particular case, an exclusive license is seen to be the only means to encourage the marketing and public use of an invention, such a license may be issued for a sufficient

but limited period of time, to provide incentive and opportunity for the development of that invention.

Whenever an exclusive license is granted, regardless of the funding source of the underlying research, we usually insert performance milestones or requirements for minimum royalty payments in order to encourage the licensee to develop the invention further, rather than merely to sequester it from the competition. In all cases, royalty income is shared between the inventors and the Institute, with the relative proportions dependent on cumulative royalty receipts.

Because universities are oriented toward exploring and expanding the frontiers of knowledge, rather than producing products, it is rare that university researchers will develop an invention capable of being transferred immediately to the market. Experience shows that it can cost orders of magnitude more to transfer a basic invention to the marketplace than it did to invent it. Someone has to be willing to carry out the transfer process, which requires time, expertise, and considerable amounts of money. Patents and licenses provide the means by which industry is encouraged to make this investment—limited-term exclusive licenses are often required to provide protection for the additional investment. MIT's experience, and I am sure that of other universities, tends to illustrate these points.

For example, methods of producing vitamin A and synthetic penicillin were both discovered at MIT. Although the technical feasibility of these inventions was successfully demonstrated in the laboratory, a considerable amount of clinical testing and Government approval was necessary prior to marketing. This, in turn, cost considerable money and required the making of numerous risk decisions.

The university itself was certainly not in a position, nor did it have the motivation or expertise, to assume this burden. Commercial licensees within the private sector were eventually located, and these licensees did risk their money, time, and effort in commercializing the inventions. Consequently, these inventions were, and still are made widely available to the public with resultant benefit to all. The university's ownership of patents and ability to negotiate reasonable licenses constitute, I believe, a major inducement to this technology transfer.

The magnetic core memory provides another significant example of the value of Government, industry, and the university cooperating in an atmosphere that encourages patent licensing and commercialization of useful ideas. The magnetic core memory was developed at MIT in the 1950's and became a primary element in the growth of the computer industry as we know it today. It was developed through Government funding, and I should note that the Government received a royalty-free right and license to all applications based on that technology.

The magnetic core has been the most widely licensed, and highest royalty earning, invention in MIT's history. For more than a decade it was the only satisfactory solution to fast computer memory, and that invention gave American computers a strong lead in foreign markets. The point I wish to make is that commercial incentives and the effective use of the private sector of our

society were necessary to transfer the university-developed inventions in a way to help each of us as citizens, both in the improvement of our health and in the advancement of our technological growth.

In my written testimony, I have included several examples of current MIT-industry agreements, to illustrate ways in which research and technology transfer can be accomplished without conflict or significant compromise of important principles. I would like to cite just two this afternoon.

The first is the MIT-industry polymer processing program, an innovative cooperative research partnership in which faculty, students, and corporate representatives are working together to create new ideas and technologies that are quickly transferred to the marketplace. The program originated in 1973, with seed funding from the National Science Foundation's experimental R. & D. incentives program. It is now fully supported by a consortium of 12 industrial firms which pay, annually, approximately \$30,000 to \$110,000, depending on size. The program's annual budget currently exceeds the entire support received from NSF over a 5-year period.

The program has demonstrated that cooperative research programs can strengthen MIT's educational process, assist industry in meeting some of its short- and long-term needs, and stimulate the thought processes involved in technical innovation. More importantly, the program has demonstrated that the realignment of institutional relationships can yield rich dividends by using existing resources more effectively, promoting synergistic interaction of people and ideas, and facilitating technology transfer. And it has demonstrated that the issues of proprietary interests and patents need not be barriers to effective collaboration, including collaboration among competing industries in the support of common research interests.

As a result of this cooperative research program, many new processes have been developed, a number of which have been patented. The patents are owned by MIT. Companies participating in the program receive royalty-free nonexclusive licenses, and share in any royalty income earned by MIT from licenses to nonmember companies.

A second example is in the area of biotechnology, where a cell culture system has been developed by researchers within MIT's Department of Nutrition and Food Science. This system provides a means of growing large volumes of cells at low cost for use in biological research, and for the production of viruses, vaccines, hormones, interferon, or other by-products of cell growth. The invention was made in the course of research sponsored by both the National Science Foundation and the National Institutes of Health.

The method was licensed by MIT to Flow General of McLean, Va. in 1977, and the license has recently been extended. Under the new agreement, the company guarantees MIT a minimum annual royalty payment, a significant portion of which will be used by MIT within the Department of Nutrition and Food Science for the performance of unrestricted research. Flow General has undertaken a program to further develop the microcarrier and make it a

commercially-viable invention, while MIT has secured patent protection in the United States and abroad.

This licensing agreement provides a good example of cooperation between Government agencies, industry, and the university in an effort to transfer this technology in a meaningful way. I believe the agreement also illustrates the basic premise of my remarks: that the development and licensing of biotechnology is subject to the same conditions, and amenable to the same solutions, as other forms of technology. And I certainly see no reason that this will not be true also for the potentially fruitful developments that may arise from the use of recombinant DNA techniques.

This concludes my prepared statement, and I would be pleased to answer any questions from the committee.

[The prepared statement of Dr. Gray follows:]

Testimony of

Paul E. Gray
President
Massachusetts Institute of Technology

Mr. Chairman, I am Paul E. Gray, President of the Massachusetts Institute of Technology. Like Dr. Kennedy, I am appearing on behalf of the Association of American Universities of the National Association of State Universities and Land-Grant Colleges, as well as on behalf of M.I.T., which is a member of both.

I appreciate, very much indeed, this opportunity to address the subcommittees on issues relating to the transfer of biotechnologies between the university and industry. I have chosen to structure my remarks broadly, focusing on the general issues of research contracts between universities and industries, and on university patent and licensing policies for technologies developed from such research. I do so primarily because experience at M.I.T. suggests that the contractual issues concerning biotechnology are not substantially different from those concerning technologies in other fields.

M.I.T.'s close relationship with industry was an integral part of the thinking of M.I.T.'s founder, William Barton Rogers, when he set out to establish the Institute. In fact, the Institute's charter from the Commonwealth of Massachusetts, granted in 1861, specifically stated the purpose of M.I.T. as "instituting and maintaining a society of the arts, a museum of the arts, and a school of industrial science, and aiding generally by suitable means, the advancement, development and practical application of science in connection with arts, agriculture, manufactures, and commerce...." M.I.T.'s early

and continuing orientation toward both the theoretical and the practical aspects of knowledge set it apart from many other institutions, and made a cooperative, mutually supportive, and interactive relationship with industry an integral part of its mission in teaching and research.

The net result of M.I.T.'s joint concern for basic and applied knowledge and its attention to real-world problems, particularly those of industry, has been that the Institute has continued to educate generations of bright and talented young people who have had substantial exposure to, and experience in solving, industrial problems by the time they leave the Institute. M.I.T. can point to great success in working with industry not only in a formal, institutional sense, but through the individual accomplishments of thousands of alumni over more than a century.

One of the primary reasons that M.I.T., as a whole, relates well to industry is found in the nature of its organization. Throughout its five Schools--Architecture and Planning; Engineering; Sloan School of Management; Humanities and Social Sciences; and Science--its new College of Health Sciences, Technology, and Management, and its numerous centers, laboratories, and programs that cross traditional disciplinary lines, students, faculty, and research staff are engaged in teaching and research that is of direct concern and relevance to industry and our nation. Its interdisciplinary

approach is probably one of the key factors that differentiates M.I.T. from most universities and makes innovation and relationships with industry a natural outgrowth of the educational process.

In earlier days, research relationships between industry and the academy were relatively simple and straightforward. Today, they tend to be much more complex, in part because each of the partners has grown in the complexity of its own distinctive characteristics. This is also a commonly held view in industry. In writing of the differences between industrial research and of academic research, as they might affect any partnership of industry and the university, Dr. Edward David, president of the Exxon Research and Engineering Company, has noted: "Major efforts have foundered because of the conflicting roles seen by the potential participants. Issues hinging on patent ownership and licensing, publication rights, protection of proprietary data and so on, have proved difficult to resolve. However, in recent times there has been progress, perhaps due to the pressures on industry for innovation and on academia for long-term, unconstrained support."

Dr. David's observations begin to bring into focus a number of issues which must be addressed in any development of research relationships and technology transfer between industry and the university. Four of the most fundamental and difficult issues, in my judgment, are the following:

1. The relevance of a proposed line of inquiry to the essential missions of the university and the industry: how to design a collaborative program which maintains balance between the university's pursuit of research as an integral part of the educational process and industry's search for useful knowledge, to be applied in the development of products, processes, and services.
2. Time-frames for research efforts: how to organize a program which provides an accommodation to the different time constants of industry and of universities, where graduate students--and their theses, which at the doctoral level may stretch over several years--are intimately involved with the research effort.
3. Proprietary rights versus openness: how to assure the protection of proprietary information provided by industry, while meeting the statutory and ethical requirements of the university--which demand that research serve a broad public good, that it be conducted in an atmosphere of openness and free exchange, and that results be available for distribution on a nonconfidential basis.
4. Patents and copyrights: how to determine methods of licensing that will promote the progress of science

and technology; assure that discoveries and inventions are utilized in ways most likely to benefit the public; and provide both adequate recognition to inventors and appropriate financial support to the universities.

In the area of publications, we find ourselves continuously attempting to balance the very legitimate desire of industry to prevent premature publication in order to protect patent rights, with the equally legitimate needs of the university to encourage the free dissemination of information. Accordingly, while we clearly cannot freeze information developed in the course of the research program, we are willing to delay proposed publication for a reasonable time period to allow the preparation of patent applications and to ensure that information proprietary to the company is not inadvertently included in the publication.

Likewise, although information developed at M.I.T. during the research program is not proprietary, the Institute will accept information which is proprietary to the industrial sponsor if it is necessary for the effective conduct of the research. In these cases, we will agree to use reasonable precautions to protect such information.

Our normal policy with regard to patents is that M.I.T. will retain ownership of all inventions made in the course of sponsored research programs. However, we will also grant

either a nonexclusive or a limited-term exclusive license to the sponsor on terms to be negotiated. There are also special cases involving joint ownership, mandatory sublicensing programs, so-called field-of-use licenses, consortium agreements and the like.

The basic aim of the M.I.T. licensing policy is to promote the progress of science and technology through the provisions of the patent system, to assure that discoveries and inventions are utilized in ways most likely to benefit the public, and provide adequate recognition to inventors as well as appropriate royalty revenues to the Institute. Where feasible, nonexclusive licenses are granted to all qualified marketing efforts. If, in a particular case, an exclusive license is seen to be the only means to encourage the marketing and public use of an invention, such a license may be issued for a sufficient period of time to provide incentive and opportunity for the development of that invention. In all cases, royalty income is shared between the inventors and the Institute, with the relative proportions dependent on cumulative royalty receipts.

Because of the large amount of federal research sponsorship at M.I.T., most of the inventions we make are developed in the course of some form of government funded program. This will surely be the case also of potential patents in the area

of biotechnology. In almost all cases, M.I.T. has been permitted to license such inventions commercially, provided we ensure the retention by the government of the right to use the invention without paying a royalty. We are also allowed by government policy to exclusively license such inventions, if this type of license is necessary as an incentive for technology transfer. If we do license exclusively, however, we typically license for a period which is eight years from the date we sign the license agreement, or three to five years from the date of the first commercial sale, whichever occurs first.

Industrial participation in, and support of, research programs at M.I.T. has been growing dramatically--more than doubling in dollar value over the past two years. Industrial support for Fiscal Year 1981 totals about \$18 million, or 10 percent of all M.I.T.'s on-campus sponsored research. As industrially sponsored research is increasing, so also we anticipate an increase in the licensing of inventions made in the course of industrially sponsored programs. In these cases, there is no government restraint on the terms of an exclusive license. M.I.T.'s own policy, however, prefers non-exclusive licenses for the life of a patent (i.e., 17 years). M.I.T.'s policy also recognizes, as does the government, that exclusive licenses may often be necessary as a commercial incentive to the industrial licensee. Accordingly, when we do

exclusively license, we try to negotiate a term which does not greatly exceed the general government guidelines.

Wherever an exclusive license is granted, regardless of the funding source of the underlying research, we usually insert performance milestones or requirements for minimum royalty payments in order to encourage the licensee to further develop the invention rather than merely to sequester it from the competition. This is all part of the Institute's goal of using the licensing of patents for the transfer of technology into the public sector for use by the public.

Because universities are oriented toward exploring and expanding the frontiers of knowledge, rather than producing products, it is rare that university researchers will develop an invention capable of being transferred immediately to the market. Experience shows that it can cost orders of magnitude more to transfer a basic invention to the marketplace than it did to invent it. Someone has to be willing to carry out the transfer process, which requires time, expertise, and considerable amounts of money. Patents and licenses provide the means by which industry is encouraged to make this investment--limited-term exclusive licenses are often required to provide protection for the additional investment. M.I.T.'s experience, and I am sure that of other universities, tends to illustrate these points.

For example, methods of producing Vitamin A and synthetic penicillin were both developed at M.I.T. Although the technical feasibility of these inventions was successfully demonstrated in the laboratory, a considerable amount of clinical testing and government approvals were necessary prior to marketing. This, in turn, involved a substantial cost and required the making of numerous risk decisions. The university itself was certainly not in a position, nor did it have the motivation or expertise, to assume this burden. Commercial licensees within the private sector were eventually located, and these licensees did risk their money, time, and effort in commercializing the inventions. Consequently, these inventions were, and still are, made widely available to the public with resultant benefit to all. The university's ownership of patents and ability to negotiate reasonable licenses constitute, I believe, a major inducement to this technology transfer.

The magnetic core memory constitutes another significant example of the value of government, industry, and the university cooperating in an atmosphere that encourages patent licensing and commercialization of useful ideas. The magnetic core memory was developed at M.I.T. in the 1950s and became a primary element in the growth of the computer industry as we know it today. It was developed through government funding (and the government received a royalty-free right and license).

The magnetic core has been the most widely licensed--and highest royalty earning--invention in M.I.T.'s history. For more than a decade it was the only satisfactory solution to fast computer memory, and that invention gave American computers a strong lead in foreign markets. The point I wish to make is that commercial incentives and the effective use of the private sector of our society were necessary to transfer the university-developed inventions in a way to help each of us as citizens, both in the improvement of our health and in the advancement of our technological growth.

Several current M.I.T.-industry agreements also illustrate ways in which research and technology transfer can be accomplished, and the needs of both the university and industry can be met without conflict or significant compromise of important principles.

1. M.I.T.-Industry Polymer Processing Program

The M.I.T.-Industry Polymer Processing Program, for example, is an innovative cooperative research partnership in which faculty, students, and corporate representatives are working together to create new ideas and new technologies that are quickly transferred to the marketplace. The program originated in 1973, with seed funding from the National Science Foundation's Experimental R&D Incentives Program. It is now

2. Exxon-M.I.T. Research Agreement

Another example, the ten-year sponsored-research agreement between Exxon Research & Engineering Company and M.I.T., signed in the spring of 1980, has received considerable national attention. The agreement, one of the largest in dollar value--and also one of the longest in duration--between a university and a corporation, provides support for research of mutual interest in the field of combustion, and assures M.I.T. the financial stability and continuity needed for the effective conduct of long-range studies. One of the major objectives is to help generate the scientific and engineering base for more efficient and environmentally safe burning of fossil fuels by utilities and industrial companies, without costly and difficult refining steps.

Under the agreement, M.I.T. has the right to file patents on all technology developed as a result of the research. The Institute, however, will grant Exxon and its affiliates an irrevocable, worldwide, nonexclusive, royalty-free license for use of all patented technology. M.I.T. will be responsible for licensing all third parties, and Exxon will share in any royalty income.

fully supported by a consortium of twelve industrial firms which pay, annually, approximately \$30,000 to \$110,000, depending on size. The program's annual budget currently exceeds the entire support received from NSF over a five-year period.

The program has demonstrated that cooperative research programs can strengthen M.I.T.'s educational process, assist industry in meeting some of its short- and long-term needs, and stimulate the thought processes involved in technical innovation. More importantly, the program has demonstrated that the realignment of institutional relationships can yield rich dividends by using existing resources more effectively, promoting synergistic interaction of people and ideas, and facilitating technology transfer. And it has demonstrated that the issues of proprietary interests and patents need not be barriers to effective collaboration, including collaboration among competing industries in the support of common research interests. As a result of this cooperative research program, many new processes have been developed, a number of which have been patented. The patents are owned by M.I.T. Companies participating in the program receive royalty-free nonexclusive licenses, and share in any royalty income earned by M.I.T. from licenses to nonmember companies.

3. M.I.T. Laboratory for Computer Science

Third, there is the example of M.I.T.'s Laboratory for Computer Science. In 1975 the laboratory set out to expand its industrial interactions, and to bring into balance research support from private and government sponsors. To do this, the laboratory has developed several different forms of corporate collaboration. In one case, a major corporation has allocated a large sum of money to the laboratory's overall program, to be used at M.I.T.'s discretion. This support is subject only to general constraints: that part of the research be in broad areas of common interest; that the sponsor be kept informed of research developments; and that interaction between laboratory faculty, staff, and students and the corporation be encouraged on an ongoing basis. Patents on inventions developed from projects supported by the sponsor are handled in several ways. If, for example, an invention results from a project receiving more than 50 percent of its funding from the sponsor, then the sponsor receives a non-exclusive, royalty-free license. If 50 percent or less of the project's funding comes from the sponsor, then any resulting license is both nonexclusive and royalty-bearing.

In another case, a corporation has contributed major pieces of newly developed hardware to the laboratory, with the understanding that the company will benefit from the knowledge

gained by faculty and students using that hardware, including software modifications developed in the course of laboratory use. In a third case, a corporation has negotiated a contract to provide the laboratory with newly developed equipment at a significant discount, in exchange for the generic design of that equipment and of related software, and with a nonexclusive, royalty-bearing license to manufacture and sell the equipment and software, where the royalties earned by M.I.T. will be applied as a credit against the Institute's purchase of the equipment.

4. Microcarrier License--Flow General, Inc.

In the area of biotechnology, my first example concerns a cell culture system developed by researchers within M.I.T.'s Department of Nutrition and Food Science. This system provides a means of growing large volumes of cells at low cost for use in biological research, and for the production of viruses, vaccines, hormones, interferon, or other by-products of cell growth. The invention was made in the course of research sponsored both by the National Science Foundation and the National Institutes of Health.

The method was licensed by M.I.T. to Flow General of McLean, Virginia in 1977, and the license has recently been extended. Under the new agreement, the company guarantees

M.I.T. a minimum annual royalty payment, a significant portion of which will be used by M.I.T. within the Department of Nutrition and Food Science for the performance of unrestricted research. Flow General has undertaken a program to further develop the microcarrier and make it a commercially viable invention, while M.I.T. has secured patent protection in the United States and abroad.

5. Collagen-Based Artificial Skin License--Marion Labs

Second, in August 1980, M.I.T. entered into a license agreement with Marion Laboratories of Kansas City, Missouri, under which Marion will proceed with the commercial development and marketing of a synthetic skin developed by an M.I.T. professor. Here again, the basic invention was developed in the course of research performed under the NIH. The invention is presently undergoing a one-year developmental review process, at the end of which a decision will be made as to whether or not to proceed with an application to the FDA for marketing this skin in hospitals to help serious burn victims. Another possible application of this invention, which might ultimately be produced in a manner similar to adhesive bandages, would be in the area of coverings for lesser burns and abrasions.

6. Skin-Equivalent Research Program and License
Option--Flow General, Inc.

Third, Flow General, Inc., as well as the Department of the Army, are presently sponsoring research in the Biology Department for the future development of a skin equivalent begun at M.I.T.

Using cells taken from the patient, an M.I.T. professor has developed a process for growing large volumes of skin which can be grafted back onto the patient. The process promises to overcome the rejection problem. Here again, the initial application of the product would be in treating serious burn victims, although it may have further applications for growing organs of the human body. The professor is presently working in conjunction with Boston's Beth Israel Hospital on further testing of the invention.

As a condition of the research agreement with M.I.T., Flow General has an option to a license for this technology.

7. Immunoassay License--Dow Chemical

As a fourth example, members of the M.I.T. Physics Department have invented an immunoassay technique that uses light scattering spectroscopy. The process is an accurate

and--it is hoped--low cost method for determining the concentration of any of a wide range of antigen or antibody molecules within the body. It should have broad application in assay work. Some possible applications might be in pregnancy tests, blood tests, or certain types of cancer detection.

This invention was licensed to Dow Chemical in December 1980 and further research is being performed both at Dow and M.I.T. The original work at M.I.T. was funded by NIH and the National Science Foundation.

8. Lecithin/Choline/Tyrosine Inventions Under Various Licenses and Options

Over the past several years, members of the Department of Nutrition and Food Science have made a series of inventions which basically involve the use of lecithin and other naturally produced ingredients, either alone or in combination with various drugs for the treatment of problems such as memory disorders, high blood pressure and hypertension, and appetite suppression. The inventions also entail the application of lecithin and tyrosine to reduce the undesirable side effects of various types of drugs presently in the market.

These inventions were licensed to or under option to Abbott Labs, Ajinomoto, Lipton, Nestle, Richardson-Merrell and

Servier in selected fields of use and markets. These companies, in turn, are sponsoring additional research at M.I.T. and elsewhere.

The various biotechnology licensing agreements provide good examples of cooperation between government agencies, industry, and the university in efforts to transfer technologies in meaningful ways. I believe they also illustrate the basic premise of my remarks: that the development and licensing of biotechnology is subject to the same conditions--and amenable to the same solutions--as other forms of technology. And I certainly see no reason that this will not be true also for the potentially fruitful developments that may arise from the use of recombinant DNA techniques.

Universities are traditionally one of the primary sources of creative thought in society, and I believe that M.I.T.'s record is particularly strong in this regard. As all of us in the field of technology are aware, however, creative thought does not in itself ensure the transfer of innovation to the world in a meaningful way. It is therefore essential that we continue to develop cooperative activities between universities and industry that will assure both the rapid and effective transfer of new technologies, and the relevance of educational programs.

Within the university we must take care, of course, that such programs do not focus on immediate needs and goals at the expense of the far-reaching education and research that are so important to the complete university-industry system. We must also be sensitive to the differences in research objectives, in time-frames for that research, in policies concerning patents and publications, and potential difficulties in communication.

It is clearly my strong conviction, which I hope I have conveyed to you, that by planning and working together, industry and the university can find ways to resolve the tough questions and build an increasingly fruitful relationship. I believe each partner has great self-interest in nurturing the partnership, as does our national need to recover our capacity for innovation and productivity.

Mr. Gore. Thank you very much.

Mr. Walgren.

Mr. WALGREN. Thank you. MIT has apparently been relatively involved with these commercial arrangements more so than other universities, is that correct?

Dr. GRAY. I have relatively little basis to draw a comparison, Mr. Walgren. I think it is probably the case that we have been more involved than most universities—perhaps because our focus is on science and technology. I might note that at the present time industrially sponsored research comprises about 9 percent of organized, sponsored research conducted at MIT, which is perhaps a factor of two or three greater than that in universities generally and a factor of three greater—greater in percentage terms—than the level which held at MIT a decade ago.

Mr. WALGREN. Have you experienced any problems with conflicts of interest? Apparently everybody is worried about this aspect, and you have had, some experience with it. Even though you are positively disposed to biocommerce in universities, what kinds of specific problems have come up with conflict of interest?

Dr. GRAY. Mr. Walgren, we undertook some years ago an experiment not dissimilar in character from that which was received so much publicity earlier this year at Harvard University. We were not focusing specifically on the area of biotechnology at the time we undertook this experiment, but saw it as a vehicle which would be broadly applicable over the whole range of science and technology of interest at MIT.

This experiment was in the form of creating, as a separately chartered captive corporation, a not-for-profit corporation chartered under the laws of Massachusetts, an organization known as the MIT Development Foundation. Its purpose was to facilitate the transfer of technology from the Institute to industry through the formation of new ventures, new companies which would be organized specifically to exploit one or another marketable ideas generated in the course of research performed at MIT. The Development Foundation was in existence for about 6 years through the middle 1970's. It no longer exists. We closed it up 4 or 5 years ago.

During its existence it brought into being four new companies, each formed around a different idea—although none, if I remember correctly was in the biotechnology area. A couple were in the area of metallurgy, material science; one in the area of applied electronics.

Our reasons for terminating that activity along about 1976 or 1977 were several, but certainly one set of reasons related to our perception of the limited leverage which this kind of activity provided in terms of creating viable and self-sustaining enterprises. But we learned also, I think, in the course of that experiment a good deal more about the potential conflicts of interest that could arise and about how those felt in real terms when one was dealing with actual situations. And that was a factor also in our decision not to continue it.

Let me give an example, a generalized example of the kinds of issues that arise. One is dealing typically with a situation in which an invention arises out of a federally-sponsored program. Three of these four I have cited, I believe, were NSF sponsored programs. The one creates a new enterprise in which a faculty member or

conceivably a faculty member, a research staff member, a former graduate student, might be both principal and equity holders in that enterprise.

The institute was also in the case of all four of these enterprises an equity holder on a relatively minor scale, a scale in the range of 5 to 10 percent of the equity. That equity came to the Institute through the development foundation as a recognition, if you will, of the effort which the development foundation made in bringing the entrepreneur, the external sources of capital, and a manager together to create an enterprise. But typically you have a faculty member who is also involved as an equity holder, perhaps as a consultant, and a faculty member who is continuing, as well, to work on this project in his laboratory, must often with continued sponsorship from the same Federal agency.

In all these cases in order to get the enterprise started, it was necessary to license on a limited term exclusive basis to the new enterprise. So you have the appearance of conflict of interest of an individual who is working with continued Federal support along the same lines to improve the technology, improve the invention; and doing so in a way in which he or she through association with the outside enterprise stands to benefit.

Now I should emphasize that all these enterprises were set up with full disclosure to everyone involved. The NSF was asked to look in detail into each of these, signed over on the exclusive license, was aware of the insurance et cetera, and of the outside enterprise. The fact that there is full disclosure in advance however, does not necessarily ameliorate the perceptions of conflict of interest that may arise after the fact. I think it was the greater intensity of the understanding of those perceptions that arose after we gained some experience with this kind of enterprise; coupled with the fact that the returns, potential returns to MIT from these enterprises seemed smaller after the fact—5 or 6 years after—than they did at the outset; coupled further with the fact that if we were going to continue this kind of activity it was going to have to be at the cost of substantial injections of unrestricted funds from the institute—all those factors taken together led us to the conclusion to wind it down which we did.

Mr. WALGREN. You expressed the appearance of conflicts of interest but how is that different from the other kinds of arrangements of the university, such as in licensing businesses?

Dr. GRAY. Well, the way in which it was different in the case of the four enterprises that were started by the development foundation was that in each of those the Institute was an owner—on a small scale, but nonetheless an owner—in that enterprise as well as being the licensor of an invention to that enterprise.

In the other activities which I have described in my written testimony—the two which I alluded to here today—the Institute has no equity interest, it is simply a licensor, and a potential benefit is that which would be associated with the royalty stream.

Mr. WALGREN. Thank you.

Mr. GORE. Mrs. Heckler.

Mrs. HECKLER. Dr. Gray, it is a pleasure to welcome you to the committee. I am pleased to have the record reflect the very impressive past experience of scientific discovery attributable to MIT.

I sense in your statements a feeling of adequacy concerning the current licensing and patenting process and that procedures already in place are protecting both the Government and the university in terms of the ethical questions that this hearing is addressing. But I wonder, is there not a difference in this area of genetic engineering. It seems that the difficulty of facilitating the transfer of technology has been overcome. Certainly the impatience of a society hungry for medical breakthroughs, Interferon for example, has been a significant impetus. Is it possible we are plowing new ground in genetic engineering and that the procedures and processes that were adequate before are simply not going to deal with the deep ethical questions that will occur fairly quickly in this new field, or would you think that this experience is just a continuation of what has already occurred?

Dr. GRAY. Mrs. Heckler, the rate at which information is transferred from the university setting to the industrial setting may indeed be increasing with respect to biotechnology broadly. I am conscious of Dr. Kennedy's comments that we are now in a situation in which the rules of the game have changed in a way because the value added is larger at the basic research end of the research development application than it has been traditionally in many areas of activity, including perhaps those which I have cited.

Indeed, if it is correct that that rate is increasing, if it is correct that the whole pace of this development is proceeding at a more rapid rate than we have been used to in other fields, there may arise concerns about the ethical questions, questions of conflicts, which are different in character from those that we have seen in the past.

I might say that with respect to these questions MIT has for a good many years been concerned about the potential conflicts and problems that arise at this interface. We have, as has Stanford, as President Kennedy explained, asked faculty members for a good many years to communicate regularly with their department chairmen about the nature and extent of their outside professional activities. We do provide guidelines that relate, as do Stanford's, to the amount of time one may spend on compensated outside professional activities. Those guidelines are a little more detailed than those that exist at most universities. We do have also a specific rule which says it is inappropriate for the member of the MIT faculty to hold a position of line responsibility, even in a part-time way, in an outside organization.

We do, as part of those guidelines, expect members of the faculty to consult with their department heads before undertaking outside activities and to report on an annual basis in writing to their department heads about the nature and extent of their outside activities. We do not require the report to include matters of compensation, but to cover time spent and the general nature of the activity. We did expand, 4 or 5 years ago, those guidelines and that annual reporting to ask that each member of the faculty review his or her activities each year in the context of potential conflicts of interest and to say: Are you undertaking activities which constitute or which could be seen to constitute a conflict of interest? And if so, please tell us about it and please talk with people at the Institute, be they department heads or someone in the research

administration office, about the nature of this activity so that those conflicts can be avoided.

Mrs. HECKLER. Obviously MIT has had a long series of experiences that have prompted a very sophisticated and fairly specific code of ethics. I wonder if the Institute would be the appropriate body to suggest to the scientific academic community at large that some similar type of code of ethics should be endorsed and supported? Is that necessary? I certainly would be skeptical of having the Government involve itself in any type of policy setting in this area. But in view of what is happening I wonder if some large organization should sponsor some type of ethical code that relates to the fairly sophisticated problems involved in the biotechnology field.

Dr. GRAY. There are already some efforts on the part of national organizations representing higher education to encourage attention to those matters. I believe it is the American Council on Education which has a statement which it urges on member institutions relating to avoidance of conflicts of interest on the part of faculty members in the performance of sponsored research and relating also to appropriate control of outside professional activities. While these statements probably need expansion and further development on the local scene, such broad statements do exist at the present time.

Mrs. HECKLER. Finally, in terms of basic philosophical questions, do you really feel that the U.S. taxpayer is getting his or her fair share as a result of research that becomes enormously profitable; research which has been funded through Federal expenditures over the years? Do you think that the present system guarantees a return to the taxpayer or should we have something more?

Dr. GRAY. I think that is a terribly important question and one that I would like to expand on a little bit in trying to answer. It was raised in the questions that Dr. Kennedy responded to and I would like to try and complete those responses.

The conduct of basic research in this country, particularly the conduct of research in the universities is and must remain an open and public enterprise and the results of that research are available generally to all who are interested in it through scientific publications, through conferences, indeed through visits to the campus. We have never turned away, would never turn away, a visitor who was interested in looking into what we are doing in a particular research area in whatever detail his interest and time permitted.

So in a sense, the public support of, and the public interest in, the underlying research enterprise centered on the research universities, in biotechnology or other areas, is reflected, sometimes in large measure, in the openness of the results, the accessibility of those results to any who would choose to apply them and put them to use.

And in some sense the arrangement mentioned here and so much in the news in the last few weeks between the German chemical company and the Massachusetts General Hospital—and I know about this also only what I read in the papers—that relationship, sometimes, builds on publicly available information in the same way it would do if that German chemical company were to come to Boston and establish in downtown Boston a private operation, not affiliated with the Massachusetts General Hospital.

Now to be sure the fact that it is affiliated, that it can draw on those facilities, that it can draw to some degree on those members of the staff who would be involved in it, gives it an advantage, there is no question about that. The point I am trying to make, however, is that the public investment in all that has preceded this is generally available and it is, as Dr. Kennedy suggested, up to those who would build on it, to come forward and do so.

That is a circuitous answer to your question, but I think the public investment in these fields is indeed repaid, if you will, or made available generally through the wide application of results. There is a great gap between the results at the level of basic research and the results at the level of marketable, profitable products. And there is a need for someone else sometimes, for some agency, some individual or corporation, to provide that additional investment, to bring an idea which develops at the level of basic research to the marketplace. Universities are not generally in that business, and university faculty are for the most part not terribly interested in that activity. One often inquires why at a place like MIT with the level of research activities, the level of patenting licenses is not larger than it is. One of the reasons is that the development of patents, and certainly the licensing of patents, and the transfer of know-how that goes with it, is just not much interest to the faculty at a place like MIT. Somebody else has to put in the additional investment, put in the money, the time. Sometimes the rewards that flow from that are tied in part to that additional, incremental investment as well as tied to the Federal base from which it all flows.

Mrs. HECKLER. Thank you.

Mr. GORE. If they are not getting anything more than what they could get from the open environment in Boston anyway, I do not understand why they are spending \$50 million.

Dr. GRAY. I do not know enough about the details of it to be able to answer that, Mr. Gore.

Mr. GORE. Mr. Shamansky.

Mr. SHAMANSKY. Yes.

Dr. Gray, I was interested in using the graph that I referred to Dr. Kennedy about the Federal Government providing 76 percent. The same graph shows that industry provides 3 percent of total university spending for basic research.

On page 7 of your testimony you say industrial participation in and support of research programs has been growing dramatically, more than doubling in dollar value over the past 2 years.

Industrial support for fiscal year 1981 totals about \$18 million or 10 percent of all of MIT's oncampus research, which is obviously 3 percent more than the average across the country.

Do you envision this as an area that should be pursued by the universities in general or are you aware of any consciousness on the part of your fellow research universities that that is the way they can and should go? Have they cooperated in this, or is it just every institution for itself?

Dr. GRAY. Well, I think this is certainly an area that we have pursued and that the growth of industrially sponsored research as a fraction of our activity from 3 percent a decade ago to 9 or 10

percent at the present time has happened as a result of concerted effort in developing that form of sponsorship.

Although I don't have the figures on it, my guess is that other research universities are moving in the same direction and that if you looked at the composition of the research program at institutions like Cal Tech or Stanford you would find similar growth, not just in dollar terms but in percentage terms of the overall program.

I think that the research universities will continue in that direction and in fact will compete with each other for that support in the same way they compete with each other for Federal support on the basis of the merits of their activities.

For us, this kind of support provides a desirable complement to Federal support; it enables us to undertake research in areas where we cannot find Federal support; it has enabled us as well to undertake research in areas with a degree of continuity and support which has not been characteristic at least in recent years, of federally supported research.

Let me give just two examples in one area, the area of energy, broadly defined. We created in 1972 an organization known as the energy laboratory. It is an interdepartmental laboratory like 30 others at MIT. This was a year before the crisis in the Mideast and the first runup in energy prices, and energy was kind of a ho-hum topic in terms of Federal support.

We saw an opportunity to bring together a number of diverse programs concerned with energy broadly and to create more than the sum of the parts by bringing about an energy laboratory. We did so at the beginning with MIT support that is, MIT unrestricted fund support—and we continued that development over the years with a very large component of industrial support and it has enabled us in that area to undertake research for which there has been and still remains no Federal sponsor, research which I think has made an important contribution to the understanding of energy policy issues and which otherwise would not have been done.

A second more recent example is the program at MIT sponsored by the Exxon Corp. for research in the combustion of carbonaceous fuels. This is a program with a 10-year time horizon. Specifically, there is an understanding between the Institute and sponsor that while either has the opportunity to disengage from this relationship on 2 or 3 years' notice, the program is intended to be a 10-year program. That gives us an opportunity to engage faculty and students in an activity on a kind of time-scale that simply has not been available with federally supported programs in this area, where one is typically working on a year-to-year basis.

Thus, I think this kind of support brings some desirable characteristics. I think this kind of support can be undertaken in the university also without compromising academic principles or values, and I believe that research universities over the coming years will be seeking such support in larger measure than they have in the past.

Mr. SHAMANSKY. Dr. Gray, I am from Columbus, Ohio. Ohio State University is across the street from Battelle Memorial Institute. Both have a research function, Battelle almost exclusively that.

Battelle, in the past, developed the technology for xerography that Xerox Corp. benefited from greatly in its equity position. Yet, listening to Dr. Kennedy, that might provide a conflict. Yet, for the university setting, it didn't apparently provide a problem for Battelle.

Do you see a difference in the standing, the ability to compete for that same research dollar from industry between a university and, say, a private research foundation?

I realize Stanford has Stanford Research. I don't know the connection between Stanford Research and Stanford University. I am throwing that out because it struck me as being a similar situation.

Mr. WALGREN. For the record, I think there is very little connection between the university and the research institute.

Dr. KENNEDY. Zero.

Mr. SHAMANSKY. Thank you.

Dr. GRAY. You ask about the competition between universities and research institutes, including not-for-profit research institutes. I think that the universities, the research universities bring a terribly important secret weapon, if you will, to that competition. That is young people, graduate students, undergraduate students.

The research universities in the United States constitute essentially a unique enterprise, not patterned after any other circumstance that I know of in the world, and certainly not copied very widely, an enterprise in which one brings together in the same physical setting young people pursuing their studies with faculty and older colleagues engaged in research activity. One tries as hard as one can to break down the boundaries between research activity and educational activity, the cost notwithstanding.

I think that that environment, infused in particular with the kind of enthusiasm, vigor, and stream of new ideas which young people bring to it, is a most unusual environment and one which gives the research universities a particular kind of vitality which in the long run enables them to outperform in terms of research the kinds of results that arise in other settings which are not regenerated continuously by the infusion of young people.

Mr. SHAMANSKY. Thank you. Thank you very much.

Mr. GORE. Mr. Weber?

Mr. WEBER. I have no questions.

Mr. GORE. How long is that agreement with Exxon?

Dr. GRAY. That was stated to be \$10 million over 10 years. We were talking there in terms of 1980 dollars. I suspect when one looks back on it, the total amount added up over 10 years will exceed the \$10 million because there is an intent to keep up with inflation over that period of time.

Mr. GORE. Is there not a danger in that arrangement that Federal money granted for R. & D. purposes is subsidizing Exxon's R. & D. work?

Dr. GRAY. Well, I think the questions of cross-subsidization are extant there, probably to the same degree that they are in the biotechnology area. That is, this work which is being done largely in the department of chemical engineering builds on a 50-year history of research in combustion. MIT has over that period of time—literally over 50 years—a distinguished program of education and research in the area of combustion.

This work is being done by people who have been involved in that, in one case over that whole 50-year period. It would not have been possible, and we would not have been of interest to Exxon as a potential source or place in which that research could be performed, had it not been for all that history. And that history in turn would not have been possible without decade after decade of research activity, most of it supported in one way or another by federally sponsored programs.

Mr. GORE. Yes.

Well, they are sticky questions, indeed. Presumably if the public makes a large investment in that line of research and a breakthrough occurs, in the best of all possible worlds the public would not want to see the country's largest energy company have free use of it while all other competitors have to pay a price to use it.

It is a competitive question, but you can always find questions in any of these relationships, I guess.

Dr. GRAY. I might emphasize that the relationship here is different in one important respect than that between Hoechst and Massachusetts General; and that is that the arrangement for licensing of inventions to Exxon is a nonexclusive arrangement. So that other enterprises who are interested in that technology could also be licensed. Presumably they would be licensed on a royalty-bearing arrangement.

The difference is that Exxon was the sponsor. If you wish, they paid upfront for that royalty, they paid upfront what someone else did through a royalty stream.

Mr. GORE. Along with the public.

Dr. GRAY. Yes. But suppose that research had been sponsored by the National Science Foundation. It would be our practice in that case—if an important result came which was widely desired—it would be our standard practice in that case to license that to any takers on a royalty-bearing basis, with the Government, as the sponsor, entitled to royalty-free use.

Mr. GORE. Do you have any cases where a member of your faculty is also a leading figure in a commercial entity, technical commercial entity?

Dr. GRAY. I suppose it depends a great deal on what you mean by a leading figure. We have one member in the faculty in the department of electrical engineering and computer science who in fact has been part-time at MIT, has been part-time for more than a decade, who is the founder and principal entrepreneur of Bose Corp. Armand Bose remains on a very part-time basis a member of the faculty, but his association with MIT is a limited one and one at this point which is confined to some teaching and areas of special interest of his own.

The fact that our guidelines say that a faculty member may not hold a position of line responsibility in an outside enterprise—he may be a consultant for it, of course, or may be an equity holder in it—but may not have a line position such as a president or director of research or other such activity does provide some limitation.

Mr. GORE. Does MIT have a policy about relationships between itself and foreign companies?

Dr. GRAY. In what respect?

Mr. GORE. A policy that would preclude the kind of arrangement that exists with Exxon, for example?

Dr. GRAY. No, we do not.

Mr. GORE. You do not have such a policy?

Dr. GRAY. No.

Mr. GORE. What is the toughest case that MIT has encountered in this area? Was it the structure that was later disbanded? Was that the toughest case you have encountered?

Dr. GRAY. Toughest case? I suppose the most difficult problems arise when one has, after investigation of the possibilities of nonexclusive licensing of an invention, proceeded to license on an exclusive basis and some other enterprise comes along afterward and says, "You haven't been evenhanded about this; we would have been quite prepared to develop this idea on a nonexclusive license and you folks went ahead and licensed to somebody else on an exclusive basis and we think you are acting unfairly and in restraint of free enterprise in that respect."

I suspect that is the toughest kind of problem. It comes along once a year or so.

Mr. GORE. Once a year?

Dr. GRAY. Yes.

Mr. GORE. What particular kinds of proposals has your institution turned down in the past?

Dr. GRAY. From industrial sponsors?

Mr. GORE. Right.

Dr. GRAY. I cannot think of a proposal that we have turned down from an industrial sponsor in the last 10 years on the grounds that we thought it would create problems of ethical difficulties. These typically could not come as unsolicited proposals. These relationships, instead, usually develop over a period of some time with both the university and potential industrial partners working at it in a fairly intensive way to develop an understanding that is satisfactory to both. It seldom comes as an unsolicited proposal. The only proposals we have turned down in the last couple years because we thought that the conditions associated with them put unacceptable constraints on the university in terms of freedom of access to information were in fact proposals from the Department of Energy.

Mr. GORE. I would like to thank you.

Our next witness is on your faculty. I wonder what damage industrial relations can do to research climate?

Dr. GRAY. We have a faculty of people who think otherwise.

Mr. GORE. Thank you very much for appearing, Dr. Gray.

Our next witness is Dr. Jonathan King, professor of Microbiology at MIT. We are certainly glad to have you here. Without objection the entire text of your statement will be put into the record at this point. We are looking forward to it and I want to personally welcome you.

Last year I had an opportunity to cohost lengthy sessions on the implications of genetic engineering for the Congress and got to know you on that occasion. And it is a pleasure to renew your acquaintance. I invite you to proceed with your statement.

STATEMENT OF DR. JONATHAN KING, PROFESSOR OF MICROBIOLOGY, MASSACHUSETTS INSTITUTE OF TECHNOLOGY, CAMBRIDGE, MASS.

Dr. KING. Thank you. Congressman Gore, Congressman Walgren, members of the subcommittee, my name is Jonathan King and I reside at 114 Charles River Road, Watertown, Mass. I am employed as a professor of microbiology at the Massachusetts Institute of Technology in Cambridge, where I am also director of the Biology Electron Microscope Facility. I have long been involved in issues concerning the social uses of biomedical science and technology, and currently serve as the vice chairman of the Committee on Biological Manipulation of the World Council of Churches. Thank you for giving me the opportunity to address the subcommittee.

ORIGINS OF PUBLICLY FUNDED BIOMEDICAL RESEARCH IN UNIVERSITIES

Over the last 30 years we have witnessed dramatic advances in our understanding of the basic biology of cells and tissues and their constituent macromolecules. Accompanying this increase in basic knowledge has been concomitant progress in our ability to manipulate biological molecules, particularly DNA and protein molecules. This has resulted in the breakthrough of gene splicing technology, which has led to even more rapid advances in basic biomedical knowledge, in a new production technology, and even the ability to alter the human genome. The direct benefits to maintenance of health and alleviation of disease have been wide ranging. To mention two, the control and elimination of major bacterial and viral diseases; the recognition that a variety of cancers—previously a mystery disease, are due to damage to the DNA of the affected cells, which is making it possible to prevent many forms of cancer, for example bladder cancer due to exposure to aniline dyes, and lung cancer due to exposure to asbestos fibers.

These advances were not the product of spontaneous activity on the part of biomedical scientists; they were the product of a conscious, coordinated, publicly funded, national policy of investing in research on basic mechanisms of health and disease. Though the first National Institute of Health was created by Congress in the late thirties, it was really the pressing need for new medical technologies brought on by the suffering of combat personnel in World War II that launched the present endeavor.

Prior to World War II major advances in physics and chemistry had been financed by private corporations such as Bell Telephone, Dupont, and General Electric. These firms have been superb examples of enlightened and productive corporate investment in basic research. However, their investments assumed the further developments of commodities for sale in the market.

No equivalent corporate investment took place in the basic biomedical sciences. The efforts of the pharmaceutical industries focused on short-term searches for therapeutic substances, and did not yield important advances in the knowledge base.

If I may depart for a moment, failure of the corporate sector to invest was a conscious policy. They could not see return on investment coming from understanding causes of disease. You cannot sell in the market the knowledge that coal causes lung disease in

miners. They responded appropriately by not signing a large portion of their funds into that arena.

Existing privately funded research institutes, such as the Rockefeller Institute, despite their excellence, were incapable of dealing with the unprecedented variety of war problems; wound infections; tropical disease in the Pacific campaigns; high-altitude difficulties; transport and storage of blood plasma; and neurological injury, to name a few.

In order to solve these problems, in 1941 the Committee on Medical Research was established as an arm of the Office of Scientific Research and Development. The CMR planned, coordinated and funded new research efforts in existing institutions, to meet the medical needs of the war effort. They also insured the dissemination of the results and their translation into practical use at the front. In 1944 the Public Health Service Act was promulgated to provide legislative authority for the Government to grant research funds to universities, a mechanism continued so productively unto the present day.

I hope that is the correct legislative history. I am a biologist, not a historian.

As was made clear in post-war congressional hearings, this process was extraordinarily successful resulting in the development of sulfa drugs, gamma globulins, and penicillin, among others. After World War II there was enthusiasm for continuing these programs and after considerable wrangling and debate over their organization the fledgling NIH took them up. The NSF was similarly established with a broader scientific mandate.

Congress recognized that the prevention of disease, the alleviation of human suffering, and the maintenance of a healthy workforce, was fundamental to the social and economic well-being of the Nation. They further recognized that the protection of health depended on understanding the nature of disease, which in turn depended on understanding the normal function of cells and tissues. Thus, both Houses of Congress have consistently supported the development of public funding for basic biomedical research, which starting with a budget of \$3 million in 1948, is now over \$3 billion. Lest we think this number is too large, bear in mind that is dwarfed by the approximate \$20 billion planned for weapons R. & D.

Thus, it has been American taxpayers who financed the training of biomedical researchers, the equipping of their laboratories, the salaries of support staff and the purchase of supplies and materials. In addition, somewhat contrary to corporate practice, they also supported the organization of open scientific meetings, travel to those meetings, the publishing of scientific journals, and the fiscal support for publishing papers. Not only has there been free and full exchange of information, but also of strains of organisms and materials you will get day to day in research.

The openness, the free exchange of ideas and information, the free exchange of strains, of protein, of techniques, have been a critical component in the creativity and productivity of the biomedical research community.

I don't mean just in the ivory tower sense, but in the translation into understanding disease, provision of therapy, hospital practice.

This freedom of communication stemmed from the fact that all of the investigators shared the same professional canon; the increase of knowledge of health and disease for the general benefit of the citizenry.

I don't mean to say there isn't professional jealousy. We have ambition and we have fame and recognition, but it is considered a departure from the normal and you are embarrassed when it comes out. It is not what you are supposed to be doing.

Those of us involved in this endeavor have been rewarded, not by great wealth, but by the intellectual and social satisfaction of our work, the opportunity to publish and disseminate our findings, the financial security of relatively stable employment in university or research hospitals. This policy of knowledge for the general good, publicly available, has been a major factor in the extraordinary productivity of the research sector.

As a further result of this fundamental openness and free exchange of ideas, materials, and techniques, there has been little conflict between the research mission of the NIH and NSF, and the educational role of universities. In fact, the excellence in the teaching and training of our young scientists is inseparable from the Federal support for research which provides the backbone and framework of the training process.

Our ability to continue to train the scientific personnel to the highest standards depends on the continuation of this relationship. It also depends on maintaining an atmosphere in which the principles of integrity, objectivity and lack of bias are concrete realities, which are adhered to by scientific teaching staffs by the mentors of the coming generations. Without this, it is not possible to train truly productive and creative scientific and technical workers in the biomedical areas. With the above background in mind, I will turn to the questions.

Question 1: What are the possible ethical and institutional problems confronting the university which enters into commercial relationships to market its research?

The direct involvement (holding equity positions) of publicly funded university researchers in corporate ventures has the following negative impacts;

(a) Individuals planning to profit personally from commercial development, by, for example, assigning patents to their own firms, tend to cut down communication with their colleagues. Once patenting becomes the mode, then individuals have a vested interest in keeping strains and techniques secret until the patent is granted. This may be up to a year; but even if less, it establishes a destructive element in scientific relations, secrecy and barriers to information flow, which retard overall biomedical progress. I will tell you that the atmosphere around biology department coffee pots has changes in the last few years. It is clear this is a new element coming in there.

This secrecy is inimical to the function and effectiveness of universities in educating future generations of scientists, as well as retarding the research effort.

The second is distortion of research priorities: Commercial investments focus on the development of products for sale. Thus, scientific workers looking toward commercial relationships turn

their research in this direction, and this usually influences the general research and training program in the laboratory. It frequently influences the content and direction of courses. However, the most important long term goal of biomedical research is to discover the causes of disease in order to prevent disease. Curing disease is what you do when you don't know how to prevent it.

In fact, the focus on cures often leads to a social policy of accepting the idea that the disease will strike, and focusing on developing and selling people a cure. A recent example has been the publicity over the production of insulin through recombinant DNA technology. This has generally obscured the fundamental question of what is it that damages the insulin producing or insulin sensing cells, which leads to diabetes.

The sale of human insulin is going to do basically nothing for diabetics. It will make a bundle for Eli Lilly and the person who holds the patent.

Let me add two other points not in the testimony.

I was stimulated by your opening remarks and Congressman Walgren's remarks in the discussion about Hoechst. If you think about asbestos, there is a long and questionable history of the sponsorship of research on asbestos and disease in the Johns-Manville Corp. I believe previous hearings brought out the fact there would be some failure on the part of the Johns-Manville to insure that all of the data about the relationship between asbestos and the disease came out into it by the medical community. Now, forget about altruism. Just loss of productivity of those people who suffered that disease is a direct economic influence on the whole society—besides the suffering of the victims.

The other point is who can one rely on? When the Boston City Council comes to Harvard to get expert advice on this new genetic knowledge, and the experts have a primary equitable position in the corporations that are about to move into Boston, you really run into a problem of who are your unbiased, knowledgeable neutrals in the case.

Question 2: Who should benefit from the commercial value of the research?

As I noted above, the development in biotechnology derived almost entirely from the investment of taxpayers dollars. In the last few years a number of commercial groups have taken the last few steps in a process that involved hundreds of previous steps. With the protection of patents, resulting from the June decision of the Supreme Court, they are converting the products into their own corporate property. As a result, the public is having to buy back what it itself financed. In my opinion, the insulin case is exactly this. NIH has a clear policy of the development of insulin. It did not depend on Eli Lilly or Genentech to get the patent and then market it. It would have been available to those very few people who might need insulin in the absence of corporate development. I will be very interested to see whether this insulin really is cheap when it comes to market.

My own knowledge on this is that these strains and processes should remain publicly owned; their commercial application may well utilize corporations with skills in these areas but this should

be done by a contracting or licensing arrangement. Let them have fair return but not ownership and overall control.

I believe agencies of the Government have been far too timid in fighting for keeping publicly funded inventions and developments to remain publicly owned and controlled, either inside of the patent mechanism, or outside of it.

When there was a need for vaccines in the past and the corporate sector wasn't willing to invest in it, the Center for Disease Control developed the vaccines. It is quite possible for Government agencies to bring some of these things into use directly.

Question 3: Is university-industry "biocommerce" merely a new means for biomedical researchers to bridge the gap between basic research and development.

Let me just say here that the transformation of basic research findings into useful application is a critically important process. President Gray and President Kennedy were correct in pointing out it is not an easy transition, but we should not confuse productive and beneficial application with commercial application. They are not necessarily the same. Numerous vaccines—practical applications of basic virological research—were developed and produced by the Government, because no corporation could envisage sufficient return on investment from their marketing. Second, many marketable products—patent medicines, or some cosmetics—have very little social benefit or utility, even though they are commercially quite useful.

Without doubt, commercial development will provide an effective channel for the transformation of basic results into applied technology, for example, in the fermentation industry, and in the development of biological processes, for converting raw material into useful products.

However, in other cases, reliance on commercial development will result in socially beneficial development remaining embryonic.

No wing of the pharmaceutical industry is interested in pursuing the idea that some of the diseases without known causes are due to some of their products or byproducts produced in the environment. We have seen how slow it is to find out about agents that cause an extraordinary level of human disease, things coming out of the pesticide industry, for example, because there hasn't been any commercial interest in that line of development.

Let me throw up the Exxon example because it has come into discussion. I think MIT and Stanford are financially very strong universities. Our institutions can often strike a good bargain with these industries. We have a lot of offers and we can hold off for a very strong agreement that protects our integrity. But MIT and Stanford are not typical of the U.S. educational institutions. They are absolutely three standard deviations off the mean in terms of their financial resources.

I am not sure that either a struggling public university whose State legislature has cut back on its funds or a smaller private institution is going to be able to strike as good a deal with Exxon as our administration was able to do, nonexclusive licensing, et cetera.

One of the things Exxon is interested in is combustion processes, the health effects of what comes out of the stack, what goes into it; Hoechst is interested in toxicity of certain possible drugs.

Let me mention two other constituencies. One is the International Chemical Workers Union. I believe they represent some of the Hoechst workers. Others are the Oil, Chemical and Atomic Workers Union, United Mine Workers who represent some of the Exxon workers. I happen to know they are intensively interested in the question of whether some of the new synfuels technology will yield special risk to those workers who are at the place where the stuff comes in dirty and the fuel comes out clean. That place itself is going to be a very dirty place.

I wonder whether they will have the special access to MIT research that Exxon will have. I have a little part in a related program, health effects of fossil fuels. Two people in my laboratory are funded by it. I was sent to graduate school by a National Institutes of Health fellowship. I was a postdoctoral fellow, NIH fellowship. I came back as an assistant professor. Almost every piece of glassware, the centrifuge, our electron microscopes, the salaries of all the people who worked for me have been paid for by the Federal Government.

If I get into a relationship with Hoechst and Exxon, there is no doubt they are getting the benefit of all that input and I want to make sure every other American sector, including their employees, have equal access to this investigation. Not everybody has the wealth Exxon has and that mechanism gives wealth a special input over just being human or numbers in biomedical technology.

Question 4: How does biomedical research compare to other disciplines?

It is not the same; physics and chemistry have to do with the tools of human activity and human use. Biomedical science has to do with the user, himself or herself, with the very underlying foundation, and this forms the underpinnings for all the other technologies. The most wonderful tool in the hands of someone who can't breathe is without social utility.

Something else is new and Dr. Gray and Dr. Kennedy have spoken in more detail about this, but I still feel it is different. In the development of the electronics industry publicly financed research made a major contribution. However, it was my understanding that the general faculty did not wear two hats, but if their commercial involvement developed past the consulting stage, they left the university and set up their own corporations. They did not pretend to be the neutral transmitter of knowledge from past generations to the next generation and at the same time act in an entrepreneurial role. They left the university and said, I'm going into business now.

In the biomedical area we have something different where people are claiming to have the same neutrality and ability to serve the public that they had before they had an equitable position in the private firm as they had afterward, and I personally find that difficult to believe.

Question 5: What mechanisms are possible to protect the interest of both parties involved?

There is an explicit conflict of interest in universities or medical school researchers receiving public funds for biomedical research, whose output should remain in the public sector, while at the same time having equity positions in corporations trying to exploit these same developments privately. My own position is that Government grantees should be limited to consultant relationships. Where the Government wants to stimulate commercial enterprise it can contract directly with the corporate sector for these services.

The NIH does that. For many things they contract directly for things they can't get out of the university environment.

That means when you write your NIH grant not only do you tell them how much money do you get from NSF and DOE and any other agency but you also tell them what else you are involved in so they can assess conflict of interest.

Is a set of guidelines or codes necessary? I am often surprised how few of our graduate students realize that they are public servants. Their check says MIT. It doesn't say American taxpayer. They have been told that it is right there should be basic research, and somehow it is right and proper that their salaries and tuition should be paid, and if you raised it maybe it would work, but when I raise it to them, that, look, you are public servants: First, you should be proud of it and, second, you should take it seriously. Other people are working hard and sweating so that you can study these things.

Everybody would rather give up their job and they would trade places with you if they could. It is important that those of our young people who are being trained in this rather important endeavor to deal with health and disease understand that they are public servants; that it is right and proper to be public servants and they should take it seriously.

As a practical step I would like to see NIH in awarding training grants to universities require that the students receive some explicit instructions in their professional responsibilities.

Now, many members of the subcommittee have noted how fast this is moving, all these issues—protection of human subjects. You have a situation where one day someone is a microbiologist, they have never seen a human patient; the next day they are growing up a bacteria that has a human gene in it; and the third day, a clinical practitioner is interested in that material to use on somebody who is actually suffering.

Suddenly they move from microbiology to a human subject situation; totally ignorant of the rules about protecting human subjects, totally ignorant of the history of the controversies around it.

You have to be very sensitive. It is very different when you deal with people. They should know about that.

They should know about lab safety and protection of animals, and they should know about the history of the NIH, et cetera.

I don't see any reason why the NIH can't ask MIT; You can show us that you can provide instruction in genetics and also say; We would like to make sure that you can provide some instruction in these other issues.

Before I conclude, the issue I spoke to in the meeting that Congressman Gore referred to, the patenting of life forms, I feel strongly about it. I didn't speak to here because I didn't realize

until I heard the opening statements how broadly the hearing was construed.

But underlying this is this court decision that says organisms can be private property; a modified organism and all its offspring can be patented.

Personally, I think that the Congress ought to clarify this. I would like to see Congress take a position and say, no, the court misinterpreted. We do not think that living things can be property.

That doesn't mean corporations can't produce insulin in bacteria. It means they can't own it in the same sense that they can own an object.

I would like to put into the hearing record—into this hearing record, if it is appropriate—the talk that was delivered by Professor Krimsky of Tufts on patenting of micro-organisms in higher life forms, social and ethical concerns, which deals with this, and my own paper which was called Arguments Against Patenting Modified Life Forms.

If I might, the conclusion of this position was that plant, animal, microbial life forms in their interrelationships with each other and the environment, provide the underpinnings for the continued development of human society.

They are too important for our survival, for our health, for our long-term prosperity, to be modified according to the narrow interests of individuals and corporations.

Human organs, cells, tissues, genes, any segments of the genes, should not be permitted to be privately patented or owned by an individual or corporation.

To the extent that such materials as human cell lines, strains of micro-organisms carrying segments to the human gene become available for practical use, they should remain in the public trust. They can still be licensed out for production purposes.

Then, coming back to the university establishment, because of the special role of biomedical science, it is my opinion that the long-term interest of the people of the United States requires the existence of a healthy, open, securely funded, biomedical research establishment whose social role is the maintenance of the health and alleviation of disease in the whole population.

This, in turn, requires an educational system which is not disturbed by—which is insulated from—pursuit of short-term goals of marketability, profitability or commercial potential of biomedical knowledge.

Thank you for giving me this opportunity.

Mr. GORE. Thank you very much, Doctor.

Let me ask you about the significance of the technology of genetic engineering. What is this about genetic engineering that is different from prior problems with electric engineering and pharmaceuticals?

Is there something sufficiently different about genetic engineering to lead this full committee, the Science and Technology Committee, to treat it much more carefully?

Dr. KING. I think the answer is yes. I would make three points, two of which are of negative concern and one of positive concern.

As you know, there has been this whole debate about hazard, but this technology is different from the chemical industry in the sense its products or byproducts are self-reproducing.

A spill from the biotechnology industry has the potential of being quite different from the spill from the chemical or oil industries in the sense if the organisms get out here and you have unfortunate side effects, they may grow and reproduce themselves and establish themselves in the ecosystem.

As you know, my position is a minority position on this. This is not shared by many of my colleagues in genetic engineering. On the other hand, I have much more of a biological background than many of them: in ecology and sociology, in public health and not just in the laboratory so that it makes a difference.

From the pollution point of view, the byproducts may be self-reproducing.

The second point on the positive side, is that, for instance, I think it is really going to transform production processes. It is going to replace all manner of things that require a thousand degrees and hydrochloric acid with something that has the possibility of being somewhat more self-renewing, much more biologically efficient.

Unless it is really important in a period where we are worried about pollution, that not to use these organisms to clean up polluted oil but to use them to take the sugar cane, the cellulose that is now thrown away and convert it without acid and heat and stuff like that into sugars and alcohol.

So it is very important that the positive directions be promoted, which is not the same as the marketable directions. There will be many positive directions that are not marketable. You can use certain guidance.

The third area—it really is true that the same technology for making the bug for this insulin commercially is the technology for modifying humans, both human somatic cells and then also human germ cells; that is, those cells whose genes are transmitted to the next generation through the sperm and egg.

When you modify the germ line you modify not just the individual, not just the relation between a doctor and a patient. You modify all future human generations. I believe very much in the concept of informed consent. I do not believe that the concept of informed consent between a subject and a researcher or clinician in the area of modification of a human gene clone is adequate.

You are doing much more than modifying that individual. You need a much broader discussion of that.

I serve on this committee with the World Council of Churches, and I can tell you that the genetic engineers may feel there is nothing special about correcting a few human genes, but many, many people in the world are not so confident that is just a small step. Many people feel it is a big step and it has to have many mechanisms for public discussion.

Mr. GORE. So the gravity of the questions raised by genetic engineering potential mandate even more of a commitment to an open research environment?

Dr. KING. Yes, especially this feedback. Patenting an organism to make the product insulin also gives you the human gene for insu-

lin, and let's say it does turn out there is a component of diabetes which is a genetic disease, we develop a genetic engineering therapy which may be the right thing to do to replace the damaged gene with the good gene, but as I understand it, Eli Lilly owns your gene and mine for insulin.

It will be contested in the courts but if you own the organism with the human gene for insulin, you own the human gene—not that physical piece of DNA but yours and mine.

I hope this is not the case but I have read the court decision quite closely and that is how I interpret it. The court decision says that if you place a piece of human DNA in an organism, you own that gene. They can prevent me from taking my DNA and putting into an organism and making it available to low-income people in Boston.

Mr. GORE. I think there might be some dispute about that. Patent laws use the adjective "novel" presumably if the human gene were cultured in another way it would still be patentable?

Dr. KING. Yes, but isn't that sad? You want to do it the best way. You don't want to have to go around the patent law for something as important as therapy.

I agree with you a smart patent lawyer will be able to beat it but I don't think that is the best national policy.

Mr. GORE. My time has expired.

Mrs. Heckler.

Mrs. HECKLER. Dr. King, you raise some mind-boggling possibilities. The extensions of current scientific inquiry are so limitless that they point to many serious, deep and very troublesome ethical questions. There is no doubt about that.

First of all, I wonder how many scientists in the scientific community feel as you do.

Dr. KING. Among the tenured or the nontenured?

Mrs. HECKLER. Among the tenured.

Dr. KING. I would say that from what I have read today that is a very commonly shared view at least in private discussion.

Many of my colleagues were very upset with what was going on at Harvard University, they are nervous about the Hoechst agreement at Massachusetts General Hospital.

It is true they are worried about funds. On the other hand, they are worried about this kind of science-for-profit situation. So I think that in that situation I really am representing perhaps a majority position—not in the Boston area but nationally.

Mrs. HECKLER. Why not in the Boston area?

Dr. KING. In the Boston area there will be a concentration of this industry. And the opportunities for equity positions are going to be extraordinary. But if you are at the University of Massachusetts or at Amherst, there probably won't be kind as much concentration of industry there. Those molecular biologists are going to be dependent on the general funding mechanisms and they will be unhappy about the barriers to information flow, secrecy, people in Boston not talking to other people.

On some of the other issues, I think that most or the majority of biologists—not the majority involved in the genetic engineering technology, they are generally in the minority—but the majority of microbiologists recognize that this is really a very, very major

technology and understand that you can't try to tell the public, don't worry about it, leave it to us, everything is going to be OK.

I don't think they share the details of my views on this, but I think they would share the idea that it should be discussed, they should be out there—the contending opinions should be heard, and that they realize that a distrustful public will do more damage in the end than trying to keep the cloak on.

Our public now is a very sophisticated public. It has had experience with the radiation industry and with the chemical industry. I can tell you that in Cambridge, Mass., in 1975, many of my colleagues thought, well, what could the Cambridge city council know about genetic engineering?

But I will tell you that the Cambridge city council actually knew something about genetic engineering. They had access to material, that had been prepared for high school biology and high school genetics teachers who were intensely interested in genetic engineering in the early seventies.

The high school, as you know, is run by the school committee. The people in the school committee are closely related to the city council. It is not true that they are totally isolated from these issues.

They lack information, they lack access to technology, but they are not as naive as people would have them be.

I know from reading your positions that you are much less naive than some of my colleagues would have us think.

Mrs. HECKLER. Dr. King, what is your opinion of the Massachusetts General Hospital case?

Dr. KING. I don't like it. The Massachusetts General Hospital is an important medical facility for someone like myself who lives in the area. It is an important national research facility. It has certain unique research capacities nationally. If some of those capacities are drained off into direction B, they are not available in direction A.

In a time when biomedical research is not expanding but just barely holding its own—I just don't believe Hoechst is doing it just for public relations. Maybe there is a certain amount of that, but, you know, through all these years that we biomedical scientists were dying for support, were hungry for support, the corporate sector was nowhere to be found.

Many times people would say "Go to the pharmaceutical industry for a grant." The pharmaceutical industry did not make hundreds of millions of dollars available for basic research.

My feeling is that Hoechst is interested in products, products that have a certain character, that focus on this thing of cure. I don't think they are interested in the cause of the disease or prevention of disease except in those cases where one might make a vaccine against the organism.

I don't see how it can benefit in the long term the overall interests of Massachusetts General and the population. Certainly the particular investigators, as Dr. Gray pointed out, will have access to resources they wouldn't otherwise have.

On the other hand, that is not to say that if I was in there and there—you know, there are bread and butter issues which are involved. I can't ask my graduate students not to patent something

they have worked on when they get a letter from our Patent Office saying, "Why don't you patent this?" If they don't, once you have patenting, their competitors will. So it is a problem.

Mrs. HECKLER. What percentage of professors on the faculty at MIT have educations totally attributable to Federal investment such as yourself?

Dr. KING. I believe the absolute great majority; I would say certainly over 90 percent.

Mrs. HECKLER. Ninety percent?

Dr. KING. Yes.

Mrs. HECKLER. That is for MIT; is that true?

Dr. KING. It is also true nationally. If you look at production of Ph. D.'s in the United States in biochemistry, somewhere between 85 and 90 percent of them are federally funded.

Mrs. HECKLER. You heard earlier Dr. Kennedy refer to one of the current tax proposals, the 25-percent tax credit for investments in research and development. I am sure with MIT's record of attracting industry funding anyway, perhaps MIT is not as seriously in need of this kind of incentive as are other institutions, but should that kind of an R. & D. development tax credit be made available for genetic research R. & D. where it is such a lucrative field and the profits are so high?

Dr. KING. I think the tax credit which encourages them to give money into R. & D.—and I presume this would be with fewer strings tied?

Mrs. HECKLER. Right.

Dr. KING. It would be just to put money into research, that I think is fine, because for a long time industry has been benefiting from investment technology. I think it is time for them to reinvest in it. I would be all for the tax credit mechanism.

I would, however, like to see some of the benefits. To give the Government a license when the Government has no mechanism to do anything with the license I think is a false benefit.

I would like to see some of those royalty fees come right back to the agency, NSF or NIH. I am taking a position somewhere in opposition to our own administration here, but it is true if I come up with an invention my ingenuity should be rewarded.

MIT provided me a building, but the NIH provided me with actual bread and butter with which I could do the research. So why shouldn't some of that come back directly?

This is the case in European countries, I believe, where the successful development of products in the market yields income that comes back directly to Government.

Mrs. HECKLER. In view of the cuts in NSF, I think there won't be a more worthy recipient for some new source of funding than NSF. I think my time has expired.

Mr. GORE. Mr. Shamansky?

Mr. SHAMANSKY. Yes.

Dr. King, when there is this directed by contract research, does that have an inadvertent negative effect or deleterious effect upon the identification received by graduate students who wouldn't have that education necessarily take that turn, or does it make any difference in the long run?

Dr. KING. I think it does. When my colleagues are working out the education of the courses and the requirements for education, you are trying to have some broad historical view that these people can be educated to take on some unknown roles in some future technology, you want to educate them as broadly as possible.

For example, in the laboratory you want to allow them to start a project and then say, "I don't like that. Not only don't I like that, I don't like you, Professor King. I don't want to work with you and I am going to work with somebody else."

The way our department is structured, and many departments in the United States, fully academic, the student has every right to do that. They are not tied to any individual particular line of research. They can do anything that can get them a Ph. D. in the context of that department.

In the contract work the graduate students are still kind of cheap labor; they are cheap labor and the post-doctoral fellows are cheap labor, et cetera. And they are very often changed to something that has to be done for the marketability of that project.

You know you need to develop a gazoo so the thing will work with one kind of threaded screws rather than another. So the student gets put on that project. He doesn't have the freedom to leave that project because the funding is tied to it.

Now, we try to avoid this and in biology it has been very easy to avoid this because we have had Federal funding and not such targeted funding.

I think there is going to be a tendency with the corporate funding for graduate education to suffer. I know personally numerous students who are in this situation who are unhappy in it. Not in my department, but in other departments where their research is tied to a contract.

The other thing that happens to them is that the contract gets dropped—it is a boom-and-bust cycle—and they are left to fend for themselves. It is also not a healthy environment.

Mr. SHAMANSKY. Are you satisfied that absent these contractual things that the graduate student would have beneficial research available to him or does this really make any difference?

I hope you get the thrust of my question.

Dr. KING. Again please.

Mr. SHAMANSKY. Supposing there weren't the contractual stuff; what assurance do we have about what would be available for the graduate student at that university without the funds to get a well-rounded education?

Dr. KING. Well, with respect, for example, to the National Institutes of Health which funds a great deal of graduate work in biomedical sciences, they award institutions and their departments training grants. These are competitive. We compete with other universities to provide graduate training in biochemistry genetics. The NIH looks over our program. They look over our courses. They come and meet with the graduate students in the absence of faculty. They say "What kind of experience are you having, what kind of problems are you having in this institution?"

The NIH reviews the educational program to ensure quality. The NSF has a similar program, not quite as organized as the NIH program.

The independent mechanism is the Accrediting Society of Colleges and Universities who also send a delegation to look over the university. But this is outside the Government.

Also, they usually don't look at graduate education so closely because it is examined by the granting institutions.

Mr. SHAMANSKY. Is it your opinion that these contracts are diverting our universities from areas that they should otherwise be in?

Dr. KING. In the area of biomedical science and genetic engineering I believe this is beginning to happen. For example, genetic engineering is a powerful technology, it allows you to study DNA molecules. You can use it to ask why is this person's DNA being damaged? Which cells of the body and tissue have been exposed to something that damages DNA? You can also use it to make some protein that you put into animal feed, as a food supplement. One is the commodity development, the other the course of the disease.

In the current situation a talented graduate student sniffs the wind. There are going to be jobs available in industry but I am not sure there are going to be jobs available in the university in biomedical research.

The first project, developing the technology to look to see whether people have been exposed to a certain kind of damage is not a commercial technology; you have to carry that forward in a university-hospital environment.

I know a few students—I know this because I tried to get them to come and do research in my laboratory. One of them got an offer to a west coast corporation that was involved in genetic engineering technology, 50 percent higher salary plus various other benefits and that—he went off in that direction. So it does feed back.

So the situation of expanding commercialization, shrinking public support, leads to diversion of people into commodity production and away from the basic mechanism of, "Why do you get sick?"

Mr. SHAMANSKY. Thank you.

Mr. GORE. Mr. Weber?

Mr. WEBER. Thank you.

I find this all very interesting. I just want to clarify one point. The funding about which you have some concerns is essentially new funding; is that not correct?

Dr. KING. Yes. This has not been available in biomedical research in the last few years.

Mr. WEBER. So what we are talking about is some concern about the direction of investment of funds that have not previously been available?

Dr. KING. Well, I have not seen any funds; what we are really talking about is professors becoming directors of new corporations with some future promise that when they make it, then funds will be returned back to the university.

I don't believe that departments I know of—well, no, Hoechst, you are right, and MGH, that is new funds available.

Mr. WEBER. That is what I am thinking of. I take it that this is going to be a growing trend, which is the point of your testimony I presume.

Dr. KING. Yes.

Mr. WEBER. Even recognizing all of your concerns, and they may be valid ones, isn't it better to have the money go in this direction than not having it available at all?

Dr. KING. Yes. On the other hand, you have a situation where everybody, you know, is saying, "Wow, this new commercial genetic engineering is going to solve all the world's problems."

I am sure you are going to have a dozen witnesses who are going to testify about this. Time magazine, Life magazine, Newsweek, Business Week, Fortune. I think it is appropriate for a few voices to point out, "Look, you lose something this way, too. Don't think that you are just going to get gravy here. We are going to lose certain things, lose a certain aspect of the integrity of the educational system, particularly in biomedical sciences."

If there is something that can be done to alleviate this, I think it should be done. Public support of biomedical sciences has been extraordinarily productive. Right now it is in a difficult, exciting situation, but kind of shaky.

Mr. WEBER. That is the gist of it, isn't it? The absence of funding for other purposes is more damaging than the existence of funding here—

Dr. KING. That's right. I have not opposed commercial funding.

Mr. WEBER. Yes.

Dr. KING. Who could be against it?

Mr. WEBER. That is an important distinction to make as we think about policies that may develop in regulating that type of arrangement.

Dr. KING. That's right. We don't want to keep Hoechst from giving money to Massachusetts General for research or even for product development; we just want to make sure it does not divert people who are continuing to receive NIH money and NSF and NCI grants from what the stated purpose of those is, and also the student, the training party.

So as we think about what I suppose you could develop into legitimate, probable regulatory have to be looked at with some skepticism and the real question is: How do we try to assure that funding is available through one source or another for some of the types of research that may be less immediately profitable?

Dr. KING. True. I would like to see some mechanism to insure personnel funded by NIH are not working for Hoechst. It can be very hard to look at that. You have a laboratory and laboratory of many people, one person is funded from Hoechst, the other from NIH, they are working together. I don't want to go into the laboratory with a heavy hand, but people should understand when they have NIH grants they are not supposed to be working for Hoechst.

Mr. WEBER. Thank you.

I don't have any more questions.

Mr. GORE. You mentioned in your opening statement that the atmosphere in the microbiological area had already changed. Can you cite specific examples, instances where the free exchange of ideas has been inhibited?

Dr. KING. Well, there are informal and anecdotal ones where someone is talking with you saying that they tried to get such and such a strain, they wrote away for it and the fellow wouldn't send

it to them. Then they sometimes wrote a second letter and still didn't get it. So, they assumed what was going on.

In other cases they received a telephone call or a note back saying, "I am sorry, we are not giving this out, we are applying for a patent on it; we are going to use this commercially," et cetera.

I think there have been numerous examples of that.

To give the atmosphere, at a recent meeting of the American Society of Microbiology, which is in Dallas, Tex., a big meeting with 6,000 or 7,000 people, there was a forum on patenting of life forms on which I spoke and three patent lawyers spoke, one from Exxon, one from a New York firm, a third from one of the small genetic engineering firms.

The one from Exxon, Albert Halloran, he told the audience—at first I thought it was tongue in cheek, but it wasn't tongue in cheek. He said in the future when you come to scientific meetings and you are going to give a presentation, consider going to a notary public and have notarized that this material you are going to say, that you give the date when you wrote it down and colleges that you are going to visit and have a professional conversation about what you are doing, consider not telling them certain things because then if they go run with what you told them, they are not in violation of any law.

You know, I was chilled by that. A few of my colleagues said it is a total change in the canon of what is proper scientific ethics and how science works.

This is a person speaking from the podium, seriously telling this audience "Change the way you do things." And I am sure that he influenced some of the assistant professors, postdoctoral fellows, who thought this is a high up at Exxon and presumably he knows his patent law.

That is a sign of the times.

Mr. GORE. Can you cite any specific examples where the education of graduate students has been distorted in the direction of a profitmaking line of inquiry?

Dr. KING. I am not in a position to speak to this in any documented fashion. I hesitate to speak to it anecdotally. I can't cite a whole series of cases.

Mr. GORE. Very well.

Dr. KING. I will say I have personal acquaintance with people who have worked with me who have left certain laboratories because they felt that their education and their work could not develop in the laboratory that was now focusing on the commercial development.

But I don't feel I can speak for them; these people have to speak for themselves.

Mr. GORE. OK. Thank you very much for coming today, Dr. King.

Our last witness today is Dr. William Raub, an Associate Director for Extramural Research and Training with the National Institutes of Health.

Dr. Raub, welcome. We are delighted to have you back as a witness.

Without objection, the text of your statement will be put into the record at this point and we invite you to proceed with any or all of it as you see fit.

**STATEMENT OF DR. WILLIAM RAUB, ASSOCIATE DIRECTOR,
EXTRAMURAL RESEARCH AND TRAINING, NATIONAL INSTI-
TUTES OF HEALTH, DEPARTMENT OF HEALTH AND HUMAN
SERVICES, BETHESDA, MD.**

Dr. RAUB. Thank you very much, Mr. Chairman.

I appreciate the opportunity to represent the National Institutes of Health at this hearing on commercializing university biomedical research; ethical and institutional impacts.

I am accompanied by Dr. Bernard Talbot, special assistant to the Director, NIH.

The NIH shares the view of the subcommittee that the subject of this hearing is both important and timely. In fact, the reason Dr. Fredrickson is not able to be with you today is that he is chairing a meeting of his advisory committee on essentially the same subject. I have arranged to furnish for the record copies of documents associated with that meeting that are likely to be of interest to the subcommittee.

[The information is available from the Subcommittee on Science, Research and Technology.]

As the principal Federal agency charged with gaining new knowledge to improve human health, the NIH always has given high priority to the ways and means through which research results become broadly available to prevent or treat disease.

We consistently have joined with the rest of the biomedical research community in viewing publication in refereed scientific journals as the primary vehicle for knowledge transfer in this area.

Indeed, the quality and quantity of such publications invariably are major yardsticks when we or others evaluate the productivity of the studies we sponsor.

Publication in refereed scientific journals is not the only means through which the NIH fosters knowledge transfer, of course. Each Institute, both directly and through its awardees, promotes professional and public education through such approaches as preparation of specialized brochures and radio and television spots.

In addition, the Institutes from time to time sponsor consensus development meetings—specialized sessions which attempt to involve all relevant perspectives on a particular technology in health care or disease prevention with a view toward achieving broad-based agreements on which research results are and which are not ready for translation into health care practice.

Associated with our emphasis on the various forms of knowledge transfer is our recognition that some research results never will be fully utilized for the public good until they are expressed as a commercial product or service.

This has led us to give special attention to the processes by which commercial organizations enjoy or build upon the fruits of NIH programs. In many cases these organizations have needed nothing more than access to the scientific literature, their ingenuity and motivation being sufficient to translate commonly available information into a product or service for which there is a market.

In other cases, however, commercial organizations have been reluctant to invest their resources in following up a research lead unless they could gain some form of privileged access to particular

research findings for a relatively long time. It is this latter class of cases that will be the focus of the remainder of this testimony.

Because success or failure in the commercialization of research results often is determined by how effectively the rights in inventions are handled, the Public Health Service has provided specific policy guidance regarding the reporting and administration of inventions and patents by its agencies and grantees.

As a matter of policy, the NIH and other PHS agencies traditionally have encouraged grantees, especially universities, to exercise their rights to inventions produced with PHS funds whenever such action seems consistent with the overall interests of the awardee institution.

We believe this policy has worked well and has been shown to be in the interests of both the public and the awardees.

There are two fundamental reasons why we continue to believe that universities and other awardees should concern themselves actively with their rights to inventions they produce with Federal funds.

First, the scientist who conceived and developed the invention frequently is in the best position to assess whether it has potential commercial value; to rely primarily on the staff of Federal agencies to do this almost surely would be both less effective and less efficient and would require substantially more personnel than are currently involved.

Second, awardees and their employees have a strong motivation to claim and promote commercialization of their inventions, namely the opportunity to gain royalties with which to support further research and development, often for long periods of time—for example, the full 17-year life of a patent—and occasionally in substantial amounts.

Given that the stability of research-intensive universities is a matter of considerable national interest, it is always gratifying to see the results of a federally funded research project not only benefiting the public in the form of an important product or service but also generating continuing revenues for the awardee long after the project and its Federal funding have terminated.

In addition to allowing grantees to obtain rights to inventions on a case-by-case basis, the DHHS for many years has had in place approximately 80 institutional patent agreements with research-intensive institutions of higher education and other not-for-profit organizations.

These agreements give the grantees first rights to inventions resulting from department-funded research while retaining the option for the department to pursue patents where the grantees do not or to march in when the grantee is judged not to be following through satisfactorily on patent rights it obtained from DHHS-funded work.

It is noteworthy that the new Patent and Trademark Act Amendments of 1980, which becomes effective July 1, 1981, gives to all not-for-profit and small business awardees the first option to ownership of inventions. This is strikingly similar to what has obtained for many years under the DHHS institutional patent agreements.

The administration of inventions and patents by universities is an area where the principles seem straightforward but where individual transactions often are extraordinarily complicated.

On the one hand, universities have every reason to want to encourage their faculties to be innovative and thereby gain new and stable sources of funding. On the other hand, universities must continually be wary of arrangements which might prevent fulfillment of educational responsibilities, interfere with the free and timely flow of new knowledge, or cause the thrust of new research ventures to be oriented in ways that, however commercially attractive, may not involve the best scientific opportunities.

The NIH does not pretend to have a prescription for this generic dilemma. Rather, we recognize that, as universities enter into commercial agreements, they will have to deal with and possibly compromise on these issues on a case-by-case basis.

The best position we believe we can take is to reaffirm our traditional encouragement for awardees to exploit their rights in their inventions whenever appropriate, to act promptly to refine our policies whenever we see an opportunity to improve NIH-university-industry relationships, and otherwise to take special action in individual cases—for example, seeking a patent directly on behalf of the Government or marching in on an awardee-owned patent—when the public interest indicates.

Although the foregoing issues have faced the NIH and its awardees for decades, the principles and processes associated with commercialization have gained new prominence in the wake of the new biology, the capability to produce an extraordinary variety of life forms that may not occur naturally.

More than ever before, biomedical scientists and their institutional governance systems are being forced to deal with matters of patents, licensing agreements, trade secrets, and the like.

For many of those involved this may be the first encounter with the world of commerce other than as a customer, and there are widespread misperceptions about what can and should be done.

For example, many biomedical scientists, perhaps most, regard the patent process as a means of institutionalized secrecy, whereas it is in fact a time-tested way to assure broad and ready access to proprietary information.

The NIH believes it has a role to play in helping the biomedical research community gain increased understanding about commercialization processes and will be prepared to broaden its traditional partnership with universities in whatever ways seem reasonable to accomplish this; instructional publications and workshops are among the approaches that deserve consideration.

Whether the commercialization problems attendant to the "new biology" are fundamentally different from those in other areas of science is arguable. In general, it seems likely that the biomedical community will be able to benefit from the experiences of their colleagues in chemistry, physics, and electronics who have produced seemingly applicable paradigms.

However, in some cases, there is good reason to believe that traditional approaches to the handling of rights to inventions and patents won't suffice and new ones will need to be developed.

For example, when a patent involves hybridomas—laboratory-fused cells that produce highly specialized proteins (antibodies) and are capable of being maintained in tissue culture indefinitely—the NIH and its awardees may have to pay as much attention to preservation and distribution of the cell lines as to the invention rights associated with them.

This is because the current state of the technology frequently does not allow other investigators to recreate a particular hybridoma in their own laboratories no matter how carefully the inventor described his or her approach. Others who wish to use the hybridoma or its products often cannot do so unless they can obtain cultures of the cells.

In closing, Mr. Chairman, I am pleased to say that I believe the NIH-university-industry relationship is sound and gives promise of growing stronger in the years immediately ahead. We are pleased your subcommittee has elected to highlight the contemporary issues in this area and look forward to working with you further.

Dr. Talbot and I will be pleased to respond to any questions as best we can.

Mr. GORE. Thank you very much. I think that a majority of participants in this area believe that the dialog concerning the safety of conducting genetic engineering research has produced a success story in resolving the problems identified at an early stage and allowing the research to continue at its own pace.

I hope that by conducting a dialog on these problems at an early stage, we can identify the concerns and address them quickly and at the same time allow the work to continue.

How does the NIH react to the Hoechst agreement and specifically to the concern that the investment of the taxpayers may be in part siphoned off by a foreign company just as it bears fruit?

Dr. RAUB. In general, Mr. Chairman, we share the interests and concerns that several of the previous witnesses have expressed.

On the whole, as the agreement is designed—as we understand it—the university (or in this case the hospital) is acting within what seems to be its best interests to insure broad and stable sources of support. In my judgment, sir, it has not, at least intentionally, entered into a Faustian bargain in terms of its future or its relationships.

The work that has previously been funded and will continue to be funded by the NIH and other sponsors of research has been funded under terms and conditions which encourage and indeed require disclosure of the results of that research in annual reports, publications, and the like.

Those research results and all future ones from Federal funding will be subject to those kinds of requirements and responsibilities and we will expect the institution to abide by the general terms of grants policies and specifically the terms of the institutional patent agreements that are in place.

In theory, Mr. Chairman, the agreement with Hoechst should be consistent with our traditional relationships and should represent an opportunity for a new source of funds to build upon what is now publicly available information rather than to inappropriately and indiscreetly exploit that information.

We obviously will pay close attention to the developments of that arrangement and others and will be prepared to refine our policies and our interrelationships as it is necessary.

Mr. GORE. With respect to patent licensing, the NIH issued guidelines. I know that your advisory board is discussing this topic today and tomorrow, but I wonder if you can give us an idea of whether or not NIH is anticipating any actions in the area of university/industry relationships for commercializing biomedical research?

Dr. RAUB. We are anticipating them in the sense that we believe that many universities and many private organizations will be at the very least exploring, if not actually entering into, some of the kinds of agreements you have heard about today.

Under the traditional patent policies we followed, and as are now mandated Government-wide in the new statute, the universities and other awardees have ample incentive to do that, and we believe we have ample mechanisms to monitor and oversee their exercise of their rights and inventions.

So long as the interests of those awards seem to be being followed out, there is no serious breach in the communications process in science; we have no particular reason to fear any of this a priori, but we will be paying close attention to it.

Mr. GORE. Mr. Volkmer?

Mr. VOLKMER. I have no questions.

Mr. GORE. Do you see this trend toward biocommerce as a natural evolution toward commercialization? Is this just commercialization as usual or is there a new dimension to the agreements we see emerging in this area?

Dr. RAUB. I can't be sure, Mr. Chairman. I believe in substantial parts of it, commercialization is usual in the sense that the same forces and interests and priorities that have been at work in other areas of science and commerce are at work here.

Dr. King and others have indicated things that are different, special, perhaps unique about the biocommerce, as you described it.

We are very sensitive to the possibility that some of these differences may, in fact, be substantial and will require different sorts of practices and policies on our part.

Mr. GORE. Would you support Dr. Kennedy's idea of holding a Silicon Valley II Conference on this problem of commercialization?

Dr. RAUB. I think it is an attractive and interesting possibility. Your earlier analogy, with regard to the DNA guidelines, on the role of the scientific community leading to the recognition of an issue and catalyzing the broad public issue of dealing with it is an attractive one.

There is no reason that such a conference doesn't deserve consideration.

Mr. GORE. All right. Thank you very much.

Tomorrow we are going to deal more specifically with Harvard University's plan for developing an equity position in the genetic engineering arena.

We will look at how specific companies react in this quickly changing environment, but before closing today I would like to recognize counsel for the minority.

Mr. CLEMENT. Dr. Raub, a few minutes ago there was some discussion about the possibility of perhaps changing the law so that funds that were generated as a result of Government-sponsored research could at least in part be recouped to the agencies directly.

How would NIH view such a proposal?

Dr. RAUB. We discussed it at some length, especially during the transition period to the new administration, where it was an early issue raised.

There is no position of either opposition or strong favoritism for it now.

We recognize that to the extent that products become successful commercially, they are part of the tax base and, therefore, flow into the Treasury on that basis.

Mr. GORE. Our Treasury or Germany's treasury?

Go ahead. I am sorry. [Laughter.]

Dr. RAUB. To the extent they flow into our Treasury, there is then, of course, the separate process of authorizations and appropriations that decides how much of it is to be available for the awarding agencies.

We would certainly be amenable to exploring an alternative or parallel arrangement where such recoupment of funds might occur directly.

On the surface, it is not evident that it offers a material benefit over the current practice.

Mr. GORE. I was summing up tomorrow's agenda.

We will also explore more deeply how the recombinant DNA research companies relate to universities. We will hear how one State government is dealing with the problem in its State universities, and with that we will adjourn until—

Mr. VOLKMER. Mr. Chairman?

Mr. GORE. Mr. Volkmer?

Mr. VOLKMER. I would like to pursue the line brought up by the minority counsel for a few minutes because this is on the record.

Prior to the change in the law, which we did as far as patent and trademarks a year ago, a year and a half ago, going hurriedly through URTAM, I find that in the past the agency had permitted the inventors to patent anyway; is that right?

Even though it was publicly funded?

Dr. RAUB. Yes, sir.

Mr. VOLKMER. Did you or did you not find that this helped encourage research, the fact that they would be entitled to a patent?

Dr. RAUB. For those institutions that organized themselves to pursue their patent rights seriously, our experience has been that it was of significant benefit both in getting things into the commercial arena and also in establishing some long-term revenues for those institutions.

In general, in my impression, many institutions have been characterized by what Dr. King described earlier, of the faculty not being particularly interested in the commercialization or the pursuit of the invention rights. In general, only the larger institutions have been able to organize themselves in such a way that an institutional patent agreement was a practical or desirable thing.

Mr. VOLKMER. In other words, what you are telling me is, in many institutions, those not organized, the fact that a patent was available had no bearing, and determination as to whether or not they wanted a research grant or to do research in a certain field? Is that what you are telling me?

Dr. RAUB. The primary reason they applied for funding for a grant was generally not the idea that something might be patentable.

They were pursuing an idea for its own sake and for its social utility.

Mr. VOLKMER. Research sake.

Dr. RAUB. And for the general social utility that that knowledge would bring. The specific idea that something was being reduced to an invention was not necessarily the driving force.

Generally I would say it was not the driving force.

Mr. VOLKMER. In other words, if we reinstituted the old prior law, except for perhaps those that are organized and said that where the public funds were used, then the knowledge was public knowledge, then with those institutions, that would have no effect on whether or not they wanted to continue research in certain fields?

Is that what you are telling me?

Dr. RAUB. My impression is probably not. For the long run, I believe the new statute will cause some institutions to look hard at the possibility and the desirability of acting more aggressively on their invention and patent portfolios, but even under the older statute, our policy allowed a case-by-case handling, whereby an institution could get the rights to the invention and could acquire ownership of the patent.

Mr. VOLKMER. Thank you.

Mr. GORE. Thank you very much. We will stand adjourned until 2 o'clock in the same room.

[Whereupon, at 4:11 p.m., the subcommittees were adjourned, to reconvene at 2 p.m., Tuesday, June 9, 1981.]

COMMERCIALIZATION OF ACADEMIC BIOMEDICAL RESEARCH

TUESDAY, JUNE 9, 1981

HOUSE OF REPRESENTATIVES, COMMITTEE ON SCIENCE AND
TECHNOLOGY, SUBCOMMITTEE ON INVESTIGATIONS AND
OVERSIGHT, SUBCOMMITTEE ON SCIENCE, RESEARCH AND
TECHNOLOGY,

Washington, D.C.

The subcommittee met, pursuant to notice, at 2 p.m., in room 2325, Rayburn House Office Building, Hon. Douglas Walgren (chairman of the subcommittee) presiding.

Mr. WALGREN. This is the second day of hearings on the issues surrounding the university and its involvement in biotechnology for profit.

These hearings are being held jointly by the Subcommittee on Science, Research and Technology, which I chair, and the Subcommittee on Investigations and Oversight, chaired by my colleague, Albert Gore.

Yesterday, we heard from two distinguished university presidents. Dr. Kennedy of Stanford discussed the benefits and problems of the university in biocommerce and Dr. Gray of MIT gave examples of current MIT-industrial ties and how they can work successfully. Both presidents were favorable toward developing cooperative relationships between the universities and industries.

A cautionary viewpoint, however, was given by a university scientist, Dr. King, who expressed some of the concerns of academia on the potential negative effects of biocommerce on the educational system.

The role of a governmental agency—the National Institutes of Health—in university-industry ties, particularly with regard to patent rights, was given by Dr. Raub, an official of NIH.

Today we will hear additional viewpoints from representatives of industry, a State government, as well as the university.

Our members had several questions yesterday concerning the recent announcement about a joint commercial effort between the Massachusetts General Hospital and a German chemical firm. Dr. Lamont-Havers is here today representing the hospital, and we appreciate his being able to come and be with us on relatively short notice.

As chief counsel of Harvard, Mr. Steiner was directly involved in the debate concerning his university going into biotechnology for profit and as a witness today he should be able to give us some first-hand insights on that particular issue.

Mr. Eggers, Mr. Schneider, and Dr. Harsanyi are officials of the company which offers a new concept in a business relationship between university and business by acting, in effect, as a middle-

man between the two. They will explain their company's role in biocommerce.

Dr. Glick, who will follow, represents a genetic engineering firm and will be able to discuss his company's relationship with the university.

Dr. Djerassi will be able to give a spectrum of viewpoints as a witness. He has worked in industry and is now in academic science and on the board of directors of a genetic firm.

Dr. Lindsey, a government official from North Carolina, will talk about the role of the State government and North Carolina universities in commercial biotechnology.

Both days of testimony, representing many viewpoints, should give us a broad picture of the issues surrounding the university's growing relationship with industry.

I want at this point to recognize my colleague, chairman of the Oversight and Investigations Subcommittee of the Committee on Science and Technology, Mr. Gore.

Mr. GORE. Thank you. Yesterday's hearing produced more questions than answers, in my opinion. The subcommittees heard sharply conflicting views on the potential for both progress and problems in this burgeoning area of biocommerce.

It is not surprising, I suspect, that those most in favor of developing new industry-university relationships are the institutional officials who have to concern themselves with the financial stability of the organizations they lead. And it is perhaps also not surprising that professors who do basic science would like to maintain the pristine atmosphere in which research was formerly done.

Finally, it's also understandable that the NIH in this era of regulatory reform and with the history of the recombinant DNA guidelines firmly in mind, would want to maintain a wait-and-see attitude about this new trend in the performance of basic research. But several important questions did emerge yesterday that I hope we will be able to get a better handle on during this afternoon's proceedings:

First, what is the proper relationship between American basic research institutions and foreign companies that compete directly with their American counterparts. The Massachusetts General Hospital-Hoechst agreement came up so often yesterday that I believed it was imperative to talk directly to the officials involved. As my colleague noted, we are fortunate to have a spokesman from Mass General here today to answer these questions.

Second, what kinds of specific concerns ultimately prompted Harvard to back off from its radical proposal to participate, on an equity basis, in genetic engineering research? Why did Harvard see dangers in areas where MIT apparently saw none?

Third, how do the companies that stand to benefit greatly from these relationships see their responsibilities not only to the public but to the taxpayers that directly or indirectly created the apparatus on which they are building?

Fourth, what can faculty do to protect the integrity of the research enterprise and the education of their students, if we are going to become increasingly involved with tangled public-private research relationships?

Finally, what kind of guidance can we at the Federal level get from State governments? To this point we have concentrated on relationships between the great private institutions of the Nation and corporations.

It is clear, to me at least, that the relationships between our public institutions and companies pose even more difficult questions since they are wholly supported by the taxpayers' dollar. The question of who benefits from these relationships is therefore more sharply focused at the State level.

In conjunction with my colleague, Mr. Walgren, I decided these hearings were important because of the enormous ethical questions that will inevitably arise as we make our way down the path of genetic engineering research. How will the great research institutions of our society respond to those questions? How will they be able to show us the way to rationality, if their financial lifeblood is inextricably connected to private enterprise that want those questions resolved in a particular way?

During the coming months I intend to explore some of these most difficult questions that lie before us, and it is perhaps only in the context of that exploration that we will see just how wise these burgeoning commercial relationships will be.

I thank my colleague.

Mr. WALGREN. Thank you, Mr. Gore.

The first witness today will be Dr. Ronald Lamont-Havers, director of research, Massachusetts General Hospital. Welcome to the committee, Dr. Lamont-Havers. We are pleased you could come and join us and we look forward to talking with you about the specifics of the situation in which Massachusetts General has been involved.

STATEMENT OF DR. RONALD LAMONT-HAVERS, DIRECTOR OF RESEARCH, MASSACHUSETTS GENERAL HOSPITAL

Dr. LAMONT-HAVERS. I can assure you, Mr. Chairman, this is quite an unexpected pleasure. I understood when I arrived here for another meeting today in another part of the city that you had some specific questions or concerns which arose yesterday.

I don't have any prepared statement, obviously, and I thought at best I would like to know what your concerns are and I'll try to respond to them.

Mr. WALGREN. Well, that's fine, and I know that sometimes witnesses go best without prepared statements because then we have more interaction between them and members of the panel. If you have any submission you'd like to make in writing to reflect on any questions that might come up today, we would be happy to include it as part of the record.

Dr. LAMONT-HAVERS. I think, Mr. Chairman, I did send to the committee an outline of the MGH-Hoechst agreement. So somewhere in the mass of papers you have, you have it. Perhaps it would be proper to make that a part of the record at this point in the record.

Mr. WALGREN. The Chair recognizes Mr. Gore.

Mr. GORE. Thank you very much, Mr. Chairman. I'd like to request from you a copy of the MGH-Hoechst contract, if we could have that for the record also. Is that possible?

Dr. LAMONT-HAVERS. That, I don't believe is possible. I think if one reads the announcement by MGH, an executive summary of the contract is in there.

Mr. GORE. Well, we'd like to see the contract.

Dr. LAMONT-HAVERS. Then I think you should get in touch with the general director of the hospital and the chairman of the board of trustees.

Mr. GORE. We will do so, and a majority of the subcommittee agreeing, we will subpoena it, if necessary, but I can't believe it'll be necessary.

Dr. LAMONT-HAVERS. I'm in no position to say yes or no to that.

Mr. GORE. Let me outline the agreement as I understand it and ask you to correct me where I'm wrong. Maybe that's the quickest way to do this.

It's a 10-year agreement for \$50 million, correct?

Dr. LAMONT-HAVERS. That's right.

Mr. GORE. The company will fund a new department at Mass General, the department of molecular biology with \$50 million provided by the company over a 10-year period. The funds will include equipment, existing lab space, and funds for a new building to be completed by 1983.

A joint board has been established to govern the agreement, three members from Mass General and three members from Hoechst; correct?

Dr. LAMONT-HAVERS. Correct.

Mr. GORE. Under the provisions of the contract the company will have first rights to licensing any new developments; correct?

Dr. LAMONT-HAVERS. That's right.

Mr. GORE. And those rights are exclusive rights, is that correct?

Dr. LAMONT-HAVERS. That's right.

Mr. GORE. Royalties will be negotiated on a case-by-case basis. Royalties from the product will reflect the contribution made by the company.

The agreement also provides for training of company personnel by the hospital. The director of the new department will be Dr. Goodman from the University of California. Five senior investigators will also be associated. Other staffing will involve 50 total people by 1983, gained from normal recruitment practices including from the rest of the hospital.

Is that correct?

Dr. LAMONT-HAVERS. That's right.

Mr. GORE. And after the new building has been completed this number will rise to 100. A separate advisory board—apart from the board of directors—will decide the focus of research. No explicit arrangement for company representatives on the advisory board; is that correct?

Dr. LAMONT-HAVERS. Correct.

Mr. GORE. The stated purpose of the agreement is to conduct basic research and not use products, although products are clearly anticipated by the exclusive licensing agreement.

Dr. LAMONT-HAVERS. That's correct.

Mr. GORE. Now, there will be people from the rest of the hospital coming into the new department. How should we react to the fact that you've signed this exclusive licensing agreement with a for-

eign chemical company in light of the fact that the American taxpayers are providing \$25, \$26 million a year to your institution, and the people who are being trained pursuant to those grants with equipment purchase by those funds are going to be working in the effort to produce products for Hoechst?

Dr. LAMONT-HAVERS. I think, Mr. Chairman, that you have a strange concept of what goes on, and I'd like to perhaps correct that.

Mr. GORE. Good. That's the purpose of the hearing.

Dr. LAMONT-HAVERS. I think that one has to look at the genesis of the whole thing. This was a purely serendipitous event, as far as Massachusetts General was concerned. Because of a series of events and the phasing out of one of our major research efforts we had space come available and also support for two professorial chairs.

We, in conjunction with Harvard Medical School, decided that there should be a department of human genetics begun at a basic level. That, similar to the other arrangements we have with Harvard—since we are the major teaching hospital of Harvard—two of the professors of the new department would be at the Mass General.

So that a search committee was appointed by Harvard in conjunction with MGH to look for the recruitment of these individuals. A number of individuals were looked at and indeed finally everybody agreed that Dr. Goodman would be acceptable. He liked us, we liked him, and he would obviously fit the position of one of the holders of those chairs at the Mass General.

At that point we became aware of the fact and not before, that the Hoechst Co. was interested in supporting work by Dr. Goodman. And so, therefore, we did not go seeking it.

Then it developed that the opportunity therefore arose to support a major new effort on the part of the hospital and of the medical school—primarily at the hospital in this instance—of a major area of research for a period of at least 10 years to give stability to that area in this present era of great instability of Federal funding, not only funding of the research itself, but also the training.

Therefore, we were faced with the opportunity to carry out good academic basic research, no strings attached, for a period of at least 10 years.

Let me go back also in time to the fact that in about 1975 the hospital, in conjunction with many other academic institutions in this country, realized that Federal funding of research was getting into at least an unstable period, which it had been for a number of years. Therefore, it was necessary that a broader base of support of research in academia was necessary that we should once again begin to strengthen our ties to industry.

One needs to look back by the way to the fact that the research at MGH began with moneys raised from industry back in 1947 of some \$500,000, so that we've always had a feeling of this at the institution.

As a result of that decision, with the help of our scientific advisory committee, the institution formulated a patent policy the following year. And following that, a consulting agreement, which we have with all of our staff.

And I would like to correct one other thing, sir, that you said when you implied in your opening statement that it was the administrators of the academic institutions which were seeking this type of support and that the scientists somehow wished to remain aloof and were not interested.

I can assure you, sir, that in institutions such as our own where the scientists are all on soft money, they have to raise their own money. The jeopardy their careers and the people who work for them is in at the present time with regard to Federal funding has put a great deal of strain on them. And so therefore they were as anxious. Thus a matter of fact, the pressure for us to get involved with industry came out of our scientific community, not out of the administration.

Mr. GORE. I understand what you are saying there, and I understand that because there is a shortage of trained people at the level Dr. Goodman has reached and his peers have reached, there is a lot of pressure on them to, as individuals, to market their talents and skills in private industry.

But, I think the record will reflect that the impetus for the educational institutions to form such ties comes more generally from those who are interested in getting some of that money for the institution and that in the case of Harvard at least, and I think in other cases, many members of the faculty have resisted such ties on the part of the institution in order to preserve the research in their department.

Dr. LAMONT-HAVERS. Well, in many respects I believe that the arguments which are going on now within academia, the soul searching, the concern of the impact on industry on academia, how this is going to destroy values is very reminiscent of the same type of arguments which went on 20 or 25 years ago when large amounts of Federal funds began to flow into the academic institutions.

There was great concern at that time of what was going to happen. So we're just going through another period of this same type of reflection.

Mr. GORE. Let me come back to my original question. We provided \$25 to \$26 million a year in direct Federal aid to Mass General. I think it's fair to say that the current biomedical research capabilities at Mass General are indebted in part to Federal support of basic biomedical research over the last 20 years.

Now, isn't it a little unfair to the American taxpayers after this 20-year investment that's ongoing at the rate of \$25 to \$26 million a year, to give the cream of the results to a foreign company that gets exclusive licensing rights?

Dr. LAMONT-HAVERS. Let's examine that rather inflammatory statement.

Mr. GORE. Rather what?

Dr. LAMONT-HAVERS. Inflammatory statement, if I may say so.

Mr. GORE. Well, I view the agreement as inflammatory.

Dr. LAMONT-HAVERS. Well, I don't think you've read it very carefully, anyway.

Mr. GORE. You haven't given it to me.

Dr. LAMONT-HAVERS. The executive summary is very good. Basically, you must remember the institution has a patent policy which

addresses the question of the patent rights, agreements, and applies to really all of our agreements with any company and how we treat our patents.

The consulting agreement is also standard for what we expect our faculty to do. The Hoechst agreement binds the institution and Hoechst to utilize the MGH patent policy and consulting agreement.

In other words, we are not treating Hoechst in any way different from any other supporter of our research—or any other industry which supports our research.

Mr. GORE. They get exclusive licensing rights; do they not?

Dr. LAMONT-HAVERS. That's exactly the same. They are not treated any differently than Johnson & Johnson would be or any other company which would tend to support our research. And this is quite in keeping with the Federal policy, the NIH policy, there is no difference.

I think there are two things that need to be pointed out. In this agreement Hoechst is primarily concerned with access to new knowledge. They are not primarily concerned with the development of patents or new products. These they can take and develop in their own labs. If that's what they wanted, they've got their own in-house laboratories which would do that for them.

Mr. GORE. Well, why was the exclusive licensing agreement necessary then?

Dr. LAMONT-HAVERS. If you were a company, and I would imagine the chairman of the board, you're not going to give \$50 million to somebody just to get advice.

Mr. GORE. Not for nothing. They're going to get something for it.

Dr. LAMONT-HAVERS. What they're getting is information.

Mr. GORE. What they're getting is also the exclusive right to market it.

Dr. LAMONT-HAVERS. They're not getting anything different from anybody else that supports that research. The American taxpayer is not supporting that research.

Mr. GORE. Does anybody else besides the American taxpayer support biomedical research at Mass General?

Dr. LAMONT-HAVERS. Yes, sir.

Mr. GORE. OK. Who? How many corporate sponsors do you have?

Dr. LAMONT-HAVERS. Well, at the present time about 4 percent is from industry. I would say that the Federal Government supports somewhere around 65 percent.

Mr. GORE. Yes.

Dr. LAMONT-HAVERS. And the others come from industry, from foundations, from various other sources.

Mr. GORE. Anybody else in genetic engineering?

Dr. LAMONT-HAVERS. No; because we really don't have any program in genetic engineering.

Mr. GORE. So all of the fruits of the genetic engineering portion of it will go to Hoechst?

Dr. LAMONT-HAVERS. That portion which they fund.

Mr. GORE. Which is the entire department.

Dr. LAMONT-HAVERS. That is so, but they can also if they don't fund anything, then they have the option of going elsewhere to get funds. Also the members of that department are faculty members,

both of MGH and Harvard, and have all of the academic freedom. There's no restriction on their interactions with anybody.

And therefore if somebody within the department interacts with somebody else somewhere else who has an NIH grant or another grant from industry, at that point the exclusive rights to Hoechst is not automatic.

Mr. GORE. Are the faculty members free to patent and license their discoveries while working in the new department?

Dr. LAMONT-HAVERS. The MGH patents and holds the patent rights.

Mr. GORE. But the professors are not?

Dr. LAMONT-HAVERS. That's the same with everybody.

Mr. GORE. I understand that. But I mean that's a limit on the—

Dr. LAMONT-HAVERS. They have the same—they're faculty members so they are bound by the same rules as anybody else.

Mr. GORE. Let me ask the question in an a priori way, and it's the same question: Is it fair to the taxpayers, having provided this amount of money and continuing to provide it, for your institution to take that base and then enter into this exclusive agreement with a foreign company, to give them exclusive licensing rights to the results of that research which has been built in such large by public money and they use it, come back over here and compete with American companies who do not have the right to the results of the research conducted by it.

Dr. LAMONT-HAVERS. But you're dealing with apples and oranges. Remember that the research at MGH—

Mr. GORE. Or maybe it's a combination of the two.

Dr. LAMONT-HAVERS. The research at the MGH is funded, as I say, 70 percent by the Federal Government.

Mr. GORE. That's fine.

Dr. LAMONT-HAVERS. The molecular biology department will be funded by Hoechst. The American people in the meantime are getting the advantages of the knowledge which is coming out of that because that's going to be freely available as it would be in any other academic department.

There'll be freedom of publication, there'll be freedom of communication; so in that way the American public are in effect getting the results of that \$50 million?

And also I think another important area is the tremendous concern within the academic community at the present time with the cutback and potential phaseout of training grants which is the future lifeblood of science. Yet in this agreement the American people will be getting advantage of the fact that Hoechst will be funding a large number of American postdoctoral fellows.

Mr. GORE. Well, then the employees of the American companies would have free access to the information that Hoechst is paying \$50 million for?

Dr. LAMONT-HAVERS. They will have the same access as they have now to academic information. There'll be no restriction as far as papers being presented, as far as papers being published, as far as talks are concerned.

That's the interesting thing about it. There is no restriction on communication in this agreement.

Mr. GORE. I appreciate the indulgence of my colleagues.

Mr. WALGREN. The Chair recognizes Mr. Brown.

Mr. BROWN. Doctor, I'd like to follow up on this just a little bit. I should say that I have no a priori criticism and I think it represents a coup for Massachusetts General, if anything, that the foreign company is not particularly interested in the applied results. They are interested in access to the basic knowledge.

You've pointed out that there are no restrictions on publication or communication and this is a question which arises quite frequently in connection with science policy. We produce a great deal of good research in this country, which is freely available to anybody else in the world because it is published quite broadly. I'm having some difficulty in understanding whether or not the foreign company, Hoechst, actually gets anything other than the opportunity to contribute to worthy research out of this arrangement.

Dr. LAMONT-HAVERS. Right. We had discussions last week with an American company and they thought that Hoechst was getting a very good deal relatively cheaply, not from the patents, not from any patents coming up, not from any great loss to the American people, but the fact is that America in this area of science is ahead, and they have the opportunity to train their people who will go back and start probably an in-house laboratory within Germany. I think that is where they are going to get their payoff.

Mr. BROWN. That is the point that hasn't been made. Now, in just thumbing through some of the European journals, I note that there are several countries that are seeking to develop nuclei of trained researchers in this area. Generally speaking, they are having to hire them from the United States. This is Hoechst's way to solving the problem by funding this program with the opportunity to have their own people trained?

Does the contract specifically provide that they may have certain individuals or certain numbers of individuals who can take advantage of this opportunity?

Dr. LAMONT-HAVERS. Yes, sir.

Mr. BROWN. That sheds an interesting light on the technology transfer process, doesn't it?

Dr. LAMONT-HAVERS. I must say that we haven't found an American company to date who is willing to subsidize us to that extent, or to subsidize molecular biology in an academic institution with so much freedom.

Mr. BROWN. Is it possible that they don't feel the need to subsidize it because they feel they already have access to the trained people.

Dr. LAMONT-HAVERS. No; I think that some of them are beginning to explore this possibility, but certainly, as I say, this one dropped out of the skies in our lap and we weren't about to turn it down.

Mr. BROWN. The normal course of events for a large enterprise which desires to get into a new field in which they do not have the technological or scientific expertise is just to steal the people from faculties. We get this report in the microelectronics industry, for example, that they are taking graduate students and professors when they can get them and using them to build up cadre by just paying them high salaries.

Is this field too new for that process to operate here, or what?

Dr. LAMONT-HAVERS. Well, I would think that it would be essential for a large European firm to be able to build up its own facilities within its own country with its own nationals, and not staff it by stealing from America.

Mr. BROWN. Well, you know the number of foreign-born doctors you are training at MGH, don't you?

Dr. LAMONT-HAVERS. Most of those are in clinical areas. We don't have that many in research.

Mr. BROWN. That is just because there is more money in the clinical areas.

Dr. LAMONT-HAVERS. Well, I won't argue that one.

Mr. BROWN. That is all, Mr. Chairman

Mr. GORE [presiding]. Will there be representatives of the company on the advisory board?

Dr. LAMONT-HAVERS. The scientific advisory board?

Mr. GORE. Yes.

Dr. LAMONT-HAVERS. No.

In other words, they will be scientists? Some will be appointed by the company, but they will not be, as far as I can recall, representatives of the company as such. They are on the overall board.

Mr. GORE. Will Federal money be used in the new department other than through the employees recruited from the hospital generally who have been trained by Federal money? Is that the only link with the Federal money?

Dr. LAMONT-HAVERS. That would be the only link that we would see at the present moment. It is visualized in the future that it is possible that, in interactions and collaborative work with others, there might be Federal funds. At that point, I think that the hospital, that the company, if by chance any patent ever arises out of that collaboration, which is unlikely, the hospital will then decide as to what happens to that in accordance with its own patent policy.

Mr. GORE. So it is envisioned as an integral part of Massachusetts General with a flow of people back and forth recombining in the different research teams and the like?

Dr. LAMONT-HAVERS. Yes, there will be a flow back and forth. One of the basic concepts is that they have to interact, the same as any other laboratory would do, with people in any other laboratory do. They cannot be isolated.

Mr. GORE. You don't think there is any other reason for concern at all? I mean, I am charged as a member of this committee with looking at the authorization money for research in this country. And, thankfully, we allocate a lot to research, we ought to allocate more.

But my constituents have concerns about it, as most Americans do, and these are not easy questions, I understand that. But here you have an enormous amount of money from the taxpayers to this research institution and you have a continuous flow back and forth between the main body of the research institution and the genetic engineering part of it. The genetic engineering part of it is funded by a foreign chemical company and they have exclusive licensing rights for the ideas leading to products that come from the genetic engineering part of it.

Dr. LAMONT-HAVERS. Which they funded.

Mr. GORE. Which they funded and which works in concert with the publicly funded portion of it. Sixty-five percent of it is coming from the public.

Dr. LAMONT-HAVERS. Right.

Mr. GORE. In the main part of the institution—I mean, is there no concern that—do you understand my question?

Dr. LAMONT-HAVERS. Oh, certainly I understand your question, Mr. Gore.

Mr. GORE. Do you understand my concern, is what I am asking?

Dr. LAMONT-HAVERS. I understand your concern, because this obviously was a concern, not only of the institution, of our own scientists, of Dr. Goodman, and of the company. We have within the institution, within Massachusetts General, established an office of technology administration whose duty it is to administer our patent policy, our consulting agreements and our licensing agreements.

I think that, because we have that office, which is well run, that therefore we have experience of looking at who funds what and, therefore, what the rights are. We will be looking carefully at any patents or inventions arising from the Hoechst or from the department of molecular biology to see indeed what monies have gone into that.

I can assure you that anything other than fully funded by Hoechst, Hoechst doesn't automatically get an exclusive license—

Mr. GORE. Is that in the agreement.

Dr. LAMONT-HAVERS. That is in the agreement.

Mr. GORE. It is in the contract?

Dr. LAMONT-HAVERS. Yes. That will be decided by the hospital, not by Hoechst.

And the same thing, by the way, with regard to our consultant agreement, the MGH's consulting agreement will prevail and the hospital will make the decision with regard to those concerns.

Mr. GORE. Under what circumstances can either party abrogate the agreement?

Dr. LAMONT-HAVERS. The abrogation, I think that there is a clause, but I would have to relook at that. Off the top of my head, I just don't remember what that is.

Mr. GORE. Now, you can see how the details of this contract are of some interest to the subcommittee?

Dr. LAMONT-HAVERS. Yes.

Mr. GORE. I do hope you can provide it to us.

Is Massachusetts General anticipating any similar deals at this point? Are you negotiating any similar deals?

Dr. LAMONT-HAVERS. We would love to, but we haven't found anybody else who is willing to do that. But we are, however, negotiating other types of agreements with industry.

Mr. GORE. Under what circumstances would you turn down money from a company?

Dr. LAMONT-HAVERS. We would, and we have turned money down if there is complete restriction on publishing, where the individuals can't publish, where they cannot have full communication of their results, in which their academic freedom is in effect stopped or restricted.

And we certainly have argued on that basis with a number of companies.

Mr. GORE. I wonder what the reaction of the French Government would be, to cite an example, if a publicly funded research institution set up an arrangement with an American company, giving an American company exclusive licensing agreements on the products of research. I wonder what Mr. Mitterand's reaction would be.

Dr. LAMONT-HAVERS. If a company wants to come up with the amount of support where there isn't any support, where you cannot get that support, or are unlikely to get that support out of the French Government over the next 10 years, where you are going to be training Frenchmen over the next 10 years, which the French Government is unlikely to support, then Mr. Mitterand can have his concerns. But I think he has to look at all sides.

Mr. GORE. Well, there are certainly questions. My colleague and I react to it in different ways. But I don't have a dogmatic view of it. I am troubled by it, as I think that taxpayers have legitimate concerns here.

Mr. BROWN. Would the gentleman yield?

Mr. GORE. I would be glad to.

Mr. BROWN. I'm trying to place this in context and I think these hearings are useful in doing that.

I'm sure the gentleman is aware we have a large number of bilateral agreements in which we jointly support research with other countries on a country-to-country basis, in and which we each train nationals of these countries, and which we each benefit through the research that is produced. This has been particularly true in the energy field. I see nothing wrong with this arrangement, and I see nothing essentially different when it involves two private entities instead of two government entities. Although I think that the concerns the doctor has expressed, such as about the right to publish and the way in which patents are handled, need to be looked at in great detail to make sure that we protect certain values.

Mr. GORE. I look forward to examining the contract carefully and at the provisions. We appreciate you coming on such short notice.

Dr. LAMONT-HAVERS. Thank you.

Mr. GORE. I would like to call now our first scheduled witness, Daniel Steiner, general counsel of Harvard University. Mr. Steiner, welcome to you. I appreciate your patience.

Without objection, the entire text of your written statement will be put into the record, and we will invite you to proceed with the presentation of any or all of it.

I have read your memorandum that you prepared relating to Harvard's consideration of the equity position, and I read President Bok's excellent statement. I got the feeling that you might have had some hand in that. I don't know if that's the case or not, but it was certainly well done and very thoughtful and we would like to hear from you. Thank you for coming.

STATEMENT OF DANIEL STEINER, GENERAL COUNSEL, HARVARD UNIVERSITY

Mr. STEINER. Thank you, Mr. Chairman. I appreciate being invited.

Harvard University and other leading research institutions in the country have a very distinct interest in the topic that this committee is considering, and we appreciate the chance to be heard about it.

Like many other universities, we have a considerable number of people working in the genetic engineering area. I can't give you an exact count, but throughout the university, considering just so-called ladder faculty, we probably have over 80 people in the medical area and in the faculty of arts and sciences who are working in genetic engineering.

Slightly over a year ago, we began consideration at Harvard of becoming involved in a new joint enterprise with some venture capital firms and with one or two of our faculty members that would have been involved in development and possibly manufacturing, of research results of the particular laboratory of this faculty member. We ended up turning it down. We decided not to do it.

That decision was reached last November, and the New York Times in describing it said, "Harvard had shunned the apple but didn't step on the serpent." I think that is a fair description of what happened, and I might talk a bit today about the apple and the serpent.

My remarks are based on a few assumptions which I might set forth at the beginning. First, there is a strong public interest in moving inventions and discoveries from universities to the marketplace—technology transfer is important. It can be helpful in solving some of the problems of productivity in our country, there may be significant benefits in the health area. The Federal Government, I think, has recognized this, particularly with new patent legislation enacted last year.

Harvard has recognized it, especially in 1975 when we adopted a new patent policy which committed the University to becoming actively engaged in technology transfer after, I guess, three centuries of passivity in the area.

The second assumption is that the process of technology transfer has some problems associated with it. Two particular areas require attention. One is that academic values must be preserved within the institution in a number of areas that are very important to the integrity and to the basic mission of the university. There are potential dangers here, which I will address later in my testimony.

A second concern is that there is a strong public interest in what universities do. Not only university resources go into research, but, as you mentioned earlier, there is a very significant amount of Federal money supporting research at universities. I think that last year approximately \$98 million came from the Federal Government in the form of grants and contracts to Harvard University.

Similarly, in terms of the public interest, universities are, in a fundamental sense, designed to serve the public interest. That is what we are here for, and we have to keep that in mind when considering technology transfer questions.

A third assumption is that universities need new sources of funds. Harvard is dependent on tuition, gifts, Federal grants and contracts, and endowment income to keep the place going for its teaching and research purposes. We are not keeping abreast of

inflation in all four means of support. Federal support is in fact likely to drop, as you know, and gifts don't keep pace.

There is a recent Urban Institute study which said that if non-profit institutions were to make up for what is going to be lost through inflation and through likely cuts in Federal support over the next 5 years, we would need a 144 percent increase in private giving. In the past 5 years, there has been a 38 percent increase in private giving to nonprofits.

Technology transfer offers some possibilities of making up part of the gap, but I should emphasize that with all the talk of a great deal of money, it is a very, very speculative business and the odds are most of us are going to lose money on this rather than make money. Harvard clearly has lost money since we have started over the past 4 years. The only chance of any payoff may come 8, 9 years in the future. And that, as I say, is a very speculative business.

The Research Corp., a nonprofit outfit involved in this area, has statistics which show that for every 1,000 disclosures from laboratories, there are likely to be 100 patentable ideas. Those 100 patentable ideas are likely to lead to 10 licenses; and of the 10 licenses, only 1 will produce significant royalties—that is royalties in excess of \$50,000 a year.

As you can see, the chances of significant success, I think, are remote.

My fourth assumption, and this I think may come slightly as a surprise, is that one ought to look at the characteristics of the scientific community within universities today. In my view, many basic scientists want involvement in the practical world, in the real world. They want to see application of the results of the work that they are engaged in.

They don't want to make it their major occupation, the major attention of their intellectual energies; but they are interested in it. It is not simply a matter of dollars. Obviously consulting does bring some monetary reward for the faculty. But I think there is some other kind of psychological need that is being filled by moving for a short period of time into the real world. Whether in industry, whether it be in the Government, or the National Science Foundation, that kind of involvement is something which universities have to recognize as a factor in scientists' lives.

This kind of involvement has many benefits to society, either through contributions that are made to industry or results of work that is done for Government. I don't think it is a bad kind of trend if it is kept in bounds.

I will turn now to the specific case we had last year where we had a choice as to how we were going to try to exploit some of the work in recombinant DNA being done in a particular laboratory at Harvard.

We initially thought that we might pursue a route different from traditional patent licensing. We were considering becoming a partial owner of a new company which would have become involved in development of work done in one of our laboratories, and possibly in manufacturing and marketing, as well.

What attracted us to it? Very simply, the apple, going back to that, looked very big and very shiny. The chances of very large and

significant financial return to support future research at the university was there. And that is, I think, the prime reason we looked at that particular form, at that particular way of trying to exploit what was being done in the laboratory.

In theory, Harvard could have become an active participant in such a company—not simply a shareholder, but also an active part of the management of the company. Had we considered that very seriously, there would have been a very special set of problems.

First, how would such a role fit into the central objectives of the university which are teaching and basic research? I think it is reasonably clear that a company that is dedicated to development, manufacturing, and marketing does not fit into that scheme very well.

Second, would we have been competent to do the job? Presidents, deans and other officers of universities are not chosen on the basis of their abilities to start up commercial companies. I think there is a very serious question whether universities such as Harvard would have had any particular competence to become involved as an active part-time manager of such a company.

Third, would Harvard's active participation in such a company be a reasonable use of Harvard's name? I think this issue exists, regardless of the actual name of the company. We had the feeling that we might, in effect, have been trading off our own name. Harvard has a reputation as an institution of teaching and research and not as one that is involved in marketing and manufacturing. There could have been, I think, a misleading effect or impression on investors and on consumers, and I think that we decided that it would be an improper kind of involvement or use of the Harvard name.

For these and other reasons, we didn't seriously consider being an active partner or manager in the company, but we did very seriously consider being what I will call a passive shareholder. Harvard might have owned 10 to 15 percent of the stock and, under the arrangement which was under discussion at that time, we would not have paid anything for that stock. Some of the faculty members, one or two of them, would have owned another portion of it, and the venture capital firms would have held the rest at the outset and, consistent with their titles, would have supplied the initial capital to get the company going.

We still, as we considered that, had a concern about the inevitable involvement of Harvard and its name in such an enterprise and whether this would constitute appropriate involvement and use of the name.

Second, no matter how you slice it, a shareholder is not totally passive, especially one that owns a significant percentage of the stock, and 10 to 15 percent would have been a significant percentage. Passivity may be particularly difficult in a company which is involved in genetic engineering, an area that has raised safety and ethical concerns.

At the moment, the university, to the extent that it speaks institutionally on such issues, can speak about these concerns with a dispassionate voice as a disinterested party. Had we become a significant shareholder in a company involved in this work, I think

our credibility, and quite rightly so, might have been subject to some question on the issue.

Third, and most significantly, we were very concerned about the perceived effect on academic values. For example, if we are in business with one of our faculty members and are trying to make appointments in those areas solely on the basis of academic criteria, it might be perceived that our commercial interests affected our academic judgment.

Mr. GORE. Could I interrupt for a moment, with the indulgence of the subcommittee?

Mr. STEINER. Sure.

Mr. GORE. We are going to have to adjourn. We have a vote on the floor that is of some significance. We will adjourn and come back in 10 minutes.

Mr. STEINER. Very good.

[Recess.]

Mr. GORE. The subcommittee will come to order.

Please proceed with your statement, Mr. Steiner.

Mr. STEINER. I will proceed and finish very quickly.

A last concern had to do with secrecy. The idea of a university is to be as open as possible, particularly in the scientific community.

There was concern if the university was in partnership with some particular faculty members, and the faculty members were continuing work in our laboratories, whether that might heighten in some way secrecy. We didn't want to jeopardize the free exchange that should exist in the laboratories to the extent that this venture might have done so.

President Bok announced on November 17 that we would not proceed with the joint venture, his main basis being that academic values are of paramount importance to the university and there was a chance those values would be jeopardized.

It is fair to say that we still have our eye on the apple, which I am defining for the moment as effective technology transfer, of moving things as expeditiously as possible from the university to the marketplace with the hope that there will be eventually, benefit to the public, and some additional dollars to support further research at the university.

I would also like to add that this is not a matter, I think, of blacks and whites, that the whole technology transfer area, all the questions of secrecy, questions of patent licensing, restrictions and agreements, these are all shades of gray. I think that if one looks at the different arrangements as a continuum on a spectrum, and we rejected one way of proceeding on that spectrum. I don't want to say that other arrangements are free of problems.

To paraphrase an old statement, I think there is no such thing as a free bite with this apple. Anytime there is a relationship between a university and industry, there are going to be questions. I think we have to keep our eye on those questions and proceed very carefully. But I am convinced that we ought to proceed, both for the sake of the university and I think generally for the country.

Thank you.

Mr. GORE. Thank you very much.

When you considered this idea, did you also consider the Federal role in university research? I know that you gave very thorough

consideration to the other questions, some of which you mentioned in your prepared statement, and all of which you mentioned very thoroughly in your memorandum at the time. Was that given consideration?

Mr. STEINER. Yes. Any kind of arrangement that we enter into or are contemplating for technology transfer has to take into account Federal policy and our obligations under our Federal research grants and contracts. At that time and, I guess, still today, we are operating under a so-called institutional patent agreement with the NIH, and NIH funds were involved in this particular professor's laboratory. I think just about every agreement that we sign in this area specifies the overriding requirement that we comply with present or future Federal law and Federal regulations as they may affect the particular agreement.

Mr. GORE. You have given so much thought to the questions in this area. I wonder what your reaction is to the dialog you heard earlier with Dr. Lamont-Havers and your reaction to the agreement announced between Massachusetts General and Hoechst?

Mr. STEINER. I would preface my comment by saying I haven't seen the agreement. But I also might say that the attorneys for the German chemical company asked about 3 or 4 months before that agreement was entered into to see a copy of an outline of an agreement that Harvard entered into with the Monsanto Co. back in 1974. We have a major research agreement between the Harvard Medical School and Monsanto.

Based on what I have heard about the MGH agreement, I am not bothered by it. I think it is something that does make sense.

I think that question that you were raising is a very fair one, but I think it might be raised in a much broader context of overall relationships between the United States and foreign countries or, in particular, between U.S. industry and foreign industry.

I imagine there are many exclusive patent licensing agreements. There is much technology transfer between American industry and the foreign countries. And I think this would be an example of that, but in a different area.

I think that MGH and the United States public is going to get many, many benefits from this. Obviously, the German company thinks that they will also. But, as a concept, I am not bothered by the agreement unless our national policy should change considerably in terms of what are considered of appropriate relationships with foreign companies.

Mr. GORE. I noticed the discussion of the Monsanto agreement with Harvard—is that in President Bok's article?

Mr. STEINER. It was mentioned in President Bok's report, yes.

Mr. GORE. Can you briefly outline that?

Mr. STEINER. Yes. It is an interesting kind of an agreement, and I think it was a path-breaker. We worked a great deal on it. The agreement involves research support principally for two scientists, but it envisioned other projects being undertaken and other projects have been undertaken under an umbrella agreement.

Monsanto supplies the financial support for the research. Also Monsanto supplies—and this is a particularly interesting aspect of the agreement—some culture materials, needed for the research which can best be manufactured by an industrial company such as

Monsanto and not by Harvard. So Monsanto, in addition to money, is providing material which we really were not capable of providing for this research.

Monsanto is also supplying some endowment money for the university to create professorships at the Medical School. What Monsanto is getting in return is interchange between the scientists who are working on this project and their own scientific staff and the possibility of patents or licenses if something patentable should come out of this.

About 2 or 3 weeks ago, I think, there was an announcement, or maybe a little bit longer ago, of some rather good work on a subsidiary project involving bone powder and the possibility of growth of bone to replace deformed bone or nonexistent bone in new babies.

It was not a principal project under this agreement, but it was a subsidiary benefit that has come out of it.

Mr. GORE. Was that the announcement subsequently clarified as not really new?

Mr. STEINER. The announcement itself in the report of the work had referred to earlier work done by some people at Berkeley, I believe, or UCLA. But the research write-up had given credit for it, and I guess it was not printed in the newspapers. I gather the researcher at UCLA was perfectly happy with the report.

Mr. GORE. That is curiously similar to one of the announcements about Interferon and a subsequent clarification about the novelty of the event announced in the press. Do you recall the incident I am referring to?

Mr. STEINER. I don't, not the details. That did not come out of Harvard, did it?

Mr. GORE. No.

OK, refer to Mr. Brown.

Mr. BROWN. I have no questions.

Mr. GORE. Are Federal funds used in the research projects involving Monsanto?

Mr. STEINER. There have been some in the past, yes, sir. I don't honestly know whether there are any today, but there were some in the past, because I know there are provisions in the Monsanto agreement concerning compliance with Federal policy.

Mr. GORE. Now, are you satisfied, as a lawyer for the university, that the agreement protects the public's investment from being used for the exclusive benefit of a single private corporation?

Mr. STEINER. I think the agreement does. Let me explain what my notion is of what serves the public interest here, and I think there obviously could be room for difference of opinion on this.

I think that the public interest is served if results of research are published and made available to the scientific community, and that is a basic provision that we insist upon in all our agreements. I think the public interest is served if the research remains under the control of the scientists at the university and not under the direction of industrial concerns. And that is a provision we insist upon in our agreements.

I think the public interest is served if work that is patentable that comes out of the universities is in fact patented, and does in fact go through the development and marketing stages. I don't

know any way of accomplishing that except through either exclusive or nonexclusive licensing arrangements with companies.

So we have the situation where the information is being made public, is being made available to the scientific community. At the same time, we are trying to lead to faster results of taking work from the university laboratory to the marketplace. And I think the public interest is served that way.

Now, ultimately, the private concern may benefit, but they also have put up in most situations a considerable amount of money to support the research and development. They have taken risks.

Mr. GORE. Yes.

Mr. STEINER. Ultimately and very speculatively, the university may benefit, but if we get any money, we are going to put it back into research. And I think that serves the public interest.

There is a small proportion of the money, as permitted under Federal policy, that can go to the inventor as a share of royalties, if there are any. And I think that does provide some incentive to cooperate in disclosure and to give some cooperation in terms of the development work to the extent that that might be necessary.

So I am satisfied that the general framework of the arrangements that we are using is consistent with the public interest.

Mr. GORE. Yes.

The announcement I referred to earlier came from Harvard with regard to—I think it involves insulin bonding.

Now, in the instance of the insulin bonding and the bone powder, announcements were made with some fanfare. And within a short period of time, clarifications were issued that actually the advance was not new, but a new twist on a discovery that had already been made. In both cases, corporate interests were involved, the value of stock was involved. And in both cases, researchers for a private institution were making the announcement.

Presumably the amount of damage done, if any, in those instances is not great. But it is coincidental that both instances would arise out of this new hybrid arrangement between commercial entities and the research institutions.

Mr. STEINER. I think the circumstances of the two announcements were different in a fundamental way, at least from my perspective as an administrator of a university. The announcement about the bone powder was put out by Harvard, and it was a Harvard University press release announcing this.

Mr. GORE. Well presumably, because they had been informed by the scientists that this was a matter of some significance.

Mr. STEINER. That is correct. We had been informed, and we had taken a look at it, and take responsibility for the press release. And the publication of the results, as I think I indicated earlier, gave credit to the work done elsewhere.

I don't think there was anything, in my mind, misleading about that announcement. It certainly is nothing with any particular commercial value. The bone powder is basically something which a lot of people are going to benefit from and conceivably some subsidiary of Monsanto will make some small amount of money from it. But I don't think this is a big money-maker, and there really were no, in my mind, or as far as I am aware, any commercial overtones in our announcement.

The announcement in the interferon area was not a Harvard announcement. It was a press conference, I believe, held by one of our professors who is associated with another company, with a company that he and a number of other leading scientists outside of Harvard are shareholders in. I really can't speak appropriately to the contents of that press conference.

Mr. GORE. Now he is on the faculty with another professor who is a principal in a competing genetic engineering company; is that correct? You have two members of the same faculty with offices along the same hallway who are principals in competing genetic engineering companies.

Mr. STEINER. That is correct. They are both principals. I don't know enough to know how competitive the businesses are, whether they are going down different lines of work or not, but there are two professors who are in the same building in the field of biochemistry who are both involved in outside companies. That is correct.

Mr. GORE. Have you noticed any effect on the research climate?

Mr. STEINER. Well, I think we are dealing with a slightly broader problem here. Scientists, like other individuals in our society, vary considerably from individual to individual. Some of them, or many of them, are particularly open in their work with their colleagues.

Others are not very open, not necessarily for any sinister reasons. They may be people who basically keep to themselves. There are people who don't want to talk about their work until they really are very, very certain that the work is right, because many scientists have been made to look foolish by something they have either reported or talked about which hasn't turned out to be correct.

There is no doubt that the existence of that kind of situation can lead to greater secrecy, can inhibit communication. There is no doubt that consulting arrangements where individual scientists are involved with companies, can possibly lead to greater secrecy.

But I think that problem ought to be considered in the context of a larger problem of communication among scientists and not in isolation. It is something that we have to keep our eye on.

Mr. GORE. Yes. And it is part of the same problem that is under discussion here, really.

Mr. STEINER. That is correct.

Mr. GORE. Well, we would certainly like to thank you for coming today. We appreciate it, and we appreciate the fine work that you have done in analyzing these issues in such a thoughtful way. Thank you very much.

Mr. STEINER. Thank you very much.

Mr. GORE. I would like to call now as a panel of witnesses, Dr. J. Leslie Glick, president of GENEX, Inc.; Dr. E. Russell Eggers; Mr. Nelson Schneider; and Dr. Zsolt Harsanyi, all with DNA Science, Inc., with E. F. Hutton, Inc.

Welcome to all of you. We certainly appreciate your willingness to come. And a particular welcome to Mr. Schneider and Dr. Harsanyi, both of whom attended a session that I hosted about, what, a year and a half ago, or several months before the *Chakraborty v. Diamond* decision, to talk about what the Congress needed to an-

ticipate out of this area. Dr. Harsanyi, welcome back to Capitol Hill.

I guess we will begin with you, Mr. Schneider.

Without objection, the entire text of our witnesses' prepared statements will be put into the record and we invite you to proceed with a summary, if you wish, or as much of it as you wish to present. Mr. Schneider?

Mr. SCHNEIDER. Well, I would prefer, since Mr. Eggers, Dr. Harsanyi and I are all coming from the same company, if you will, that Mr. Eggers, Dr. Harsanyi and myself follow in that order if it is OK with you.

Mr. GORE. That is OK with me. Go ahead.

STATEMENTS OF E. RUSSELL EGGERS, NELSON SCHNEIDER AND DR. ZSOLT HARSANYI, DNA SCIENCE, INC., E. F. HUTTON & CO.; AND DR. J. LESLIE GLICK, PRESIDENT, GENEX, INC.

Mr. EGGERS. Mr. Chairman and members of the subcommittee, I particularly want to thank you for inviting us to testify today. We are a new company in biotechnology and are directly involved in the technology transfer from the scientific community to the marketplace.

I will give you our bottom line first. We do not believe that genetic engineering will corrupt the campus, to put it as simply as I can. There are many sensitive ethical questions which have to be handled correctly in our opinion, however, and these questions need a constructive rather than a divisive dialog, and that is why we are all here today.

Just a word about our individual backgrounds so you can see where we are coming from.

I am chief executive of DNA Science. It is an operating company founded but not controlled by E. F. Hutton. I am not a scientist but a businessman, more of the corporate executive type rather than the venture capitalist type. My background is having run a high technology chemical specialty company and I have also done a lot of joint ventures in the international area.

For those who do not know him, Dr. Harsanyi is vice president of DNA Science, Inc. Prior to that he served here in Congress as head of the OTA study on applied genetics. He is a geneticist.

Nelson Schneider is also a vice president of the company. He has been a drug analyst for E. F. Hutton for the last 7 years and was one of those who brought the whole industry of biotechnology to the attention of Wall Street institutional investors.

I will cover very briefly three questions:

What are the major trends in biotechnology and genetic engineering that have a bearing on the relationship between business and the university?

Your question No. 4, how does the technology transfer in the life sciences differ from its precedents in other technologies?

And third, what have we learned in DNA Science, Inc., as sort of a case example that might be useful to the committee.

I suppose we are one of the middlemen or brokers referred to earlier, although I must admit I do not particularly like that phrase. Anyhow, there is no doubt that recombinant DNA and gene splicing has captured the imagination of Wall Street and the

investing public. There is both a positive and a negative side to this, in our opinion, positive because it puts high-risk capital at work in a new technology, but in our opinion it is negative because the equation seems to part strongly from past standards of economic evaluation which, in turn, only exacerbates the question of potential venality and conflict of interest on the campus.

There is an interesting statistic to back up the last point. E. F. Hutton has calculated that the current market value of the 10 leading genetic engineering companies is about \$1.2 billion. These 10 companies as a group do less than \$50 million in combined product sales and actually operate at a loss. I hasten to add: Don't worry about that. The stock market mechanisms are pretty healthy and brutal. They will take care of the excesses and reward the excellences over time.

Long term, we are talking about some very serious science, I believe. The way we look at this is that recombinant DNA is not just a set of new products and a new industry, or even a new technology. The developments in molecular biology today are actually a new tool which has the potential to revolutionize the pharmaceutical and health-care industries as we know them and also have a very dramatic impact on agriculture, energy, and many other industries.

Perhaps I can use an analogy. We all know that high-speed computers run complex factories and that many computers and numerical tapes give instructions to machine tools. Well, if the living cell is a factory—and it is in many respects—the modern biologists have learned how to change the logic or instructions in that factory or living cell. So, yes, I am afraid you can fool Mother Nature after all.

Another statistic you might like: Each of you as a living being has something on the order of 6 billion cells. Each one of those cells has about a meter of DNA in it. One human being's DNA would probably stretch about 4 million miles, or about 25 times around the Earth. What is mind bending is that modern science has learned how to go in and, with chemical scissors, cut that DNA in a very precise spot, take it out, put it in a vector, play around with it, put it back in, resequence it, glue it. We are really talking about changing the logic of any living system.

From a hard-nosed business point of view, I will give you my quick version of the dynamics and the unknowns of the genetic revolution.

First, R. & D. in the new technology by governments, universities, and business will increase geometrically and will reach a level, a multi-hundred million dollar level by the 1990's.

Second, there will be strong investor interest, with mystique, that often departs from the short-term economic realities. Genetic engineering companies are being cloned into existence every day. Some of them are serious; some of them are not.

Third, we can expect intense rivalry between competing pharmaceutical companies, between academic scientists at the leading life science universities, between countries on the international level.

Fourth, in such a technology base revolution, there will be considerable cross-licensing, joint ventures and shared patents. I call

this sort of an entrepreneurial and corporate kind of incest which I believe will take place in genetic engineering.

Fifth, developments in the new biology will be international, with the U.S. playing perhaps less of a dominant role than it has, for example, in the semiconductor industry or in space technology.

Sixth, the law, particularly patent law, and Government regulations on an international basis will evolve to accommodate and control to a degree the new life science.

What now is different in the technology transfer of the life sciences as compared to other disciplines?

There are many differences, but I will single out four that seem to me rather important when comparing biotechnology to physics, engineering or space technology.

The first difference lies in the sheer scientific scope and potential industrial importance of modern biology. This is a matter of personal judgment, of course, but I would guess that when the record is written, biotechnology and the tool of genetic engineering will turn out to be more like the development of electricity or digital computer logic in all its forms than it is like the semiconductor industry or a family of pharmaceuticals such as antibiotics. I am talking, of course, long term—maybe 10, 15 years. This is the time it takes for a major new science to develop and become effective.

The second difference is that biotechnology is very interdisciplinary. The science will be pushed not by a few scientists or engineers who leave campus to do their own thing, but by interacting teams of molecular biologists, immunologists, virologists, biochemists, chemists, clinical doctors, process engineers, fermentation experts, and others.

A third difference lies in the spectacular public awareness of genetic engineering. Believe me, when taxi drivers in New York and farmers in Kansas are both convinced that gene splicing is important, then it is important.

The last difference is that biotechnology will be market-intensive rather than capital-intensive. In the pharmaceutical industry, for example, it costs in the range of some \$50 million to \$100 million to introduce a single new drug, or to put it another way, for every dollar of successful R. & D. in the drug industry, it costs an additional \$7 to \$8 for applied research, pilot plant scaleup, market testing and development.

All these factors have had a direct bearing on how we organized and structured DNA Science, Inc. Since we are directly involved with scientists on the campus and since we are somewhat different than some of the genetic engineering companies, I thought I should tell you something about the company.

We were founded earlier this year by E. F. Hutton with the strategic mission of commercializing scientific advances in genetic engineering and related biotechnology. Our initial joint venture is with Yeda Research and Development, which involves access to life science technology at the well known Weizmann Institute of Science in Rehovot, Israel. This represents a \$25 million commitment over 5 years to fund and commercialize research and development. We have a daughter company with the Israelis, which is 80 percent owned by DNA Science, 20 percent owned by the Israelis.

I will skip over some of the product portfolios we have because we are a little short of time.

I might also mention that the Israeli venture is not our only one. We do have another one, still preliminary, with the Battelle Institute in Columbus, Ohio; and we have a preliminary joint venture agreement with Dr. John Baxter of the University of California in San Francisco.

Let me say a few words about our joint venture with the Weizmann Institute. We had many sensitive issues to resolve. They were the academic freedom of the scientists who would own the patents, complex tax questions, the rights of the scientists to publish, detailed project agreements with the individual scientists, royalty payment issues, the use of the Weizmann name, and many, many others. I think that what made all of these issues manageable was that up front we had decided to be joint-venture partners with the Israelis, sharing with the Weizmann Institute both the risks and rewards of joint equity ownership.

The Weizmann Institute—and it is a pretty classy life science institution for those who know it—they felt strongly, and Hutton agreed, that it was not proper to do a public issue of stock, at least not until the time when a solid base and a successful R. & D. program had been achieved. Thus, our initial financing of between \$40 and \$50 million which will be completed this month is basically anchored with institutional investors rather than the retail public. I am talking about insurance companies, banks, pension funds, individuals of means in some cases, and companies.

Another important principle was that the Weizmann Institute itself was not directly involved in the selection of individual research projects on its campus. I think this was wise since the difficult selection process was not compromised by campus politics. Selection of the R. & D. was strictly a business decision.

DNA Science, Inc., plans similar joint ventures with other universities. Unlike some companies who are raiding campuses for talent, we have a strong desire to keep leading scientists on the campus. We believe that even in the 1990's the best of life science talent will still be on campus working with but not working for business and industry.

Will genetic engineering corrupt the campus? Again, a simple answer to that complex question is no, provided the sensitive issues are handled well by the scientists themselves, their universities, and industry. What is needed, however, and this is my conclusion, is a good dialog on the issues as well as new mechanisms of technology transfer that are appropriate to technology in the genetic engineering field.

[The prepared statement of Mr. Eggers follows:]

STATEMENT OF E. RUSSELL EGGERS, CHIEF EXECUTIVE OFFICER, DNA SCIENCE, INC.

Mr. Chairman and members of the subcommittee, both my colleagues and I at DNA Science, Inc. want to thank you and the committee for the invitation to testify today. As a new company in biotechnology, we are directly involved in technology transfer from the scientific community to the market place.

Just to give you our bottom line first: we do not believe that genetic engineering will corrupt the campus. There are many sensitive ethical questions which have to be handled correctly. These questions need a constructive dialogue and that is why we are here today.

A word about our individual backgrounds. My name is Russell Eggers. I am chief executive officer of DNA Science, Inc., a new operating company founded but not controlled by EF Hutton. I am not a scientist but a businessman, more of the corporate executive type rather than venture capitalist, with a background of having run a specialty chemical company and international joint ventures. With me today is Dr. Zsolt Harsanyi, Vice President of DNA Science. Dr. Harsanyi is a geneticist and before joining the company was project director for the U.S. Senate's recent study on applied genetics. Also with me is Mr. Nelson Schneider, Vice President of DNA Science. Mr. Schneider has been a drug analyst for EF Hutton and played a role in bringing biotechnology to the attention of Wall Street's institutional investors.

I thought it might be useful for me to cover briefly three questions today:

- (1) What are the major trends in biotechnology and genetic engineering that have a bearing on the relationship between business and the university?
- (2) How does technology transfer in the life sciences differ from its precedents in other technologies?
- (3) What have we learned in DNA Science, Inc., as a case example, that might be useful to the Committee?

There is no doubt that recombinant DNA or gene-splicing has captured the imagination of Wall Street and the investing public. There is both a positive and negative side to this. It is positive because it puts high risk capital at work in a new technology. It is negative because the equation seems to depart from past standards of economic valuation which, in turn, only exacerbates the question of potential venality and conflict of interest on the campus.

There is an interesting statistic to back up the last point. EF Hutton has calculated that the current market value of the 10 leading genetic engineering companies is \$1.2 billion. Those 10 companies as a group do less than \$50 million in product sales and actually operate at a loss. No worry. The stock market mechanisms will take care of the excesses and reward the excellence over time.

Long term, we are talking about some very serious science. The potential of genetic engineering or gene splicing is very

large. We are not talking about a set of new products, a new industry, or even just a new technology. Rather, the developments in molecular biology are a new tool of mind-boggling proportions that has the potential to revolutionize the pharmaceutical and health care industries, as we know them, and also have a dramatic impact on agriculture, energy and many other industries.

Let me use an analogy. We all know that high speed computers run complex factories and that minicomputers and numerical tapes give instructions to machine tools. Well, if the living cell is a factory, and it is in many respects, then the modern biologist has now learned how to change the logic or instructions in that factory or living cell. Yes, I'm afraid you can fool Mother Nature after all.

From a "hard-nosed" business point of view, it is already clear what some of the dynamics and unknowns of the genetic revolution will be:

Firstly, R&D expenditures in the new technology by governments, universities and business will increase geometrically -- reaching a multi-hundred million dollar level per year by the 1990's;

Secondly, there will be strong investor interest, with mystique, that often departs from the short term economic realities. Genetic engineering companies are being cloned into existence every day now; some of them serious, some of them not;

Thirdly, one can expect intense rivalry between com-

peting pharmaceutical companies, between academic scientists at the leading universities, between countries on the international level;

Fourthly, in such a technology base revolution, there will be considerable cross licensing, joint ventures, shared patents -- sort of an entrepreneurial and corporate "incest" as the genetic engineering industry develops;

Fifthly, developments in the new biotechnology will be international, with the U.S. playing perhaps less of a dominant role than it has in the semiconductor industry, or space technology; and

Lastly, the law and government regulations on an international basis will evolve to accomodate, and control to a degree, the new life science. There will be many sensitive issues to resolve.

What now is different in the technology transfer of the life sciences, as compared to other disciplines?

There are many differences but I will single out four that seem to me important when comparing biotechnology to physics, engineering or space technology.

(1) The first difference lies in the sheer scientific scope and potential industrial importance of modern molecular biology. This is a matter of judgement, of course. But I would guess that biotechnology and the tool of genetic engineering is more like the development of electricity or digital

computer logic in all its forms than it is like the semiconductor industry or a family of pharmaceuticals such as antibiotics. I am talking long term -- say 10 - 15 years, maybe longer, for a major new science to develop and have its impact.

(2) The second difference is that biotechnology is very inter-disciplinary. The science will be pushed, not by a few scientists or engineers who leave campus to do their own thing, but by interacting teams of molecular biologists, immunologists, virologists, biochemists, chemists, clinical doctors, process engineers, fermentation experts.

(3) A third difference lies in the spectacular public awareness of genetic engineering. Believe me, when taxi drivers in New York and farmers in Kansas are both convinced that gene-splicing is important, it is -- as I'm sure that any Congressman knows already.

(4) The last difference is that biotechnology will be marketing-intensive rather than capital intensive. In the pharmaceutical and health industry, it costs in the range of \$50 - 100 million to introduce a single new drug. Or to put it another way, in the drug industry for every dollar of successful R&D it costs an additional \$7 to 8 for applied research, pilot plant scale up, market testing and development.

The factors I have been discussing had a direct bearing on how we organized and structured DNA Science, Inc. as a

company. Since we are directly involved with scientists on the campus and since we are somewhat different from other genetic engineering companies, let me briefly describe our company.

DNA Science, Inc. is a new company founded by EF Hutton in January, 1981, with the strategic mission of commercializing scientific advances in genetic engineering and related biotechnology. DNA Science's initial joint venture is with Yeda Research and Development which involves access to selected life science technology at the well-known Weizmann Institute of Science in Rehovot, Israel. This represents a \$25 million commitment (over 5 years) to fund and commercialize R&D. The daughter company, Taglit, will be 80% owned by DNA Science, 20% owned by Yeda.

The technology base for the joint venture with Yeda is an initial package of 19 specific R&D projects which involve three kinds of interferon, synthetic vaccines, monoclonal antibodies, new kinds of wheat based on genetic engineering, a dielectric scanner used to detect incipient breast cancer, a new lithium drug carrier system and other basic and applied research projects in biology and chemistry.

The 19 Israeli projects were selected by Hutton and outside consultants to Hutton, from a larger number (43) of proposals made by Weizmann scientists. This is not start-up R&D but 19 projects that represent over 100 man-years of research

already performed in Rehovot at the Institute.

DNA Science has a second joint venture, still preliminary, with the Battelle Memorial Institute of Columbus, Ohio, and a preliminary agreement with Dr. John Baxter, well known scientist at the University of California (San Francisco) who wants to remain on campus with his team but also joint venture on the outside in recombinant DNA work.

In our negotiations with the Weizmann Institute and their scientists there were many sensitive issues to resolve -- the academic freedom of the scientists, who would own the patents, complex tax questions, their rights to publish, project agreements with individual scientists, royalties payments, use of the Weizmann name and many others, I think that what made all of these issues manageable was that up front we had decided to be joint venture partners, sharing with the Weizmann Institute both the risks and rewards of joint equity ownership.

The Weizmann Institute felt strongly, and Hutton agreed, that it was not proper to do a public issue of stock, at least until a solid business base and successful R&D had been accomplished. Thus, our initial financing of \$50 million, which will be completed this month is with institutional investors such as insurance companies, banks, pension funds, wealthy individuals and companies.

Another important principle was that the Weizmann

Institute itself was not directly involved in the selection of individual research projects on its own campus. I think this was wise since the difficult selection process was not compromised by campus politics. The selection was strictly a business decision.

DNA Science, Inc. plans similar joint ventures with other universities. Unlike some companies who are raiding the campus for talent, we have a strong desire to keep leading scientists on the campus. We believe that even in the 1990's the best of the life science talent will still be on campus; working with but not working for business and industry.

Will genetic engineering corrupt the campus? The simple answer to that question is no, if the sensitive issues are handled well by the scientists themselves, their universities and industry. What is needed, however, is a good dialogue on the issues as well as new mechanisms of technology transfer that are appropriate to the exciting field of biotechnology and genetic engineering.

Mr. BROWN [presiding]. Thank you very much, Mr. Eggers. Would you continue, Dr. Harsanyi?

Dr. HARSANYI. Mr. Brown and other members of the subcommittee: I, too, am very pleased to be here today and I am particularly pleased because prior to my current position at DNA Science, as you know, I served with the Office of Technology Assessment. My perspective, therefore, is based on my 2 years of analysis of biotechnology and genetic engineering at the OTA and my previous 10 years on the faculty of the Cornell Medical College in New York.

Several decades of basic and somewhat esoteric university research have been responsible for catapulting biology into the limelight that we see today. Biology, and genetics in particular, have been recognized as valuable tools for solving many of society's problems. These would include development of new food supplies, completely novel and increased amounts of pharmaceuticals, and also novel approaches to pollution control and still a host of other applications.

As I have said over many periods, like its sister sciences chemistry and physics, biology is finally coming of age. It is being recognized as a technology in its own right, and I think the neologism biotechnology points that out. Still the transition from a point at which biology has been recognized as a valuable industrial tool to the actual point of its implementation has been extremely rapid, and this is why we are here today. There are some problems that have arisen as a result. One of these is the question of the university and industry interaction.

It is in the area of the university, as we all know, that most of the research has been carried out to date, and a large portion of it continues to date and there are basically three reasons, and this is the crux of what I would like to talk about.

The first of these is that most scientists and many of the exceptionally good ones want to remain on campus. This is what we have found over the past several months talking to scientists. The reasons are varied. Some are simply that they are unfamiliar with the industrial environment. It can range to anything, that they are more comfortable with tenure and whatever the campus has to offer.

A second factor I think in this area is that things have progressed so rapidly in this area that scientists haven't had the chance to make the transition totally to industry, to leave their caps and gowns behind. As we all know, the elapsed time from the point at which the first rat insulin gene was cloned to the point at which human insulin made by the recombinant DNA method was put into clinical trials was only 4 years, so the pace has been extraordinarily rapid.

A second reason why much of the expertise remains on campus is, as we found in our OTA study, many of the successes of applied genetics and the applications of biology are due to the interdisciplinary nature of the technology that Mr. Eggers referred to before. We have found, without listing all of them, that a whole range of disciplines are really involved in making any technology transfer successful in this area. So much of this expertise lies on campus and any single, small genetic engineering company some-

times cannot pull together all the various forces that are necessary to make it successful.

Third, much of the research in biotechnology cannot simply be categorized as being basic as opposed to applied research. As one of our scientists said recently, a study that he is working on in which he is looking at the genetic code is basic in the sense that it gets to the very core of what the genetic code is about, but if he can solve this problem it may be of tremendous industrial use because it can increase productivity a hundred-or-so fold.

The point is, the basic scientist on campus doing basic research may end up doing some extraordinarily important industrial research.

So the message from all of the foregoing is very clear. The universities do now and will continue to have something which industry needs: This reservoir of expertise.

Let me just end on two points: That there are two solutions to tapping in on this expertise. One of these is to wait for the scientist to leave the campus and move into industry; and also in this area we can find that some of the scientists may be causing a lot of problems because they will be taking their expertise away from the campus. This is a kind of a brain drain that some people are worried about. Again, in our OTA study we have talked to some contractors who said that in molecular plant genetics there are such few experts available, that those who are available have been drawn totally away from the campus by industry and as a result there is no generation of scientists left to train the next generation of plant molecular geneticists. This is a great fear now in plant molecular genetics.

If we are to avoid this, and let me end on this, there is one hope, and this is what we believe: That we can set up meaningful interactions between the universities and industries not to drain the scientists away from the campus but to find some meaningful way to get the scientists to work together. The mechanisms must be sensitive to the needs of both. The university scientist's need for independence and the desire to followup stimulating leads versus industry's need to be highly goal-directed, or the scientist's need for open communication versus industry's need for patent protection or the scientist's need to be able to work with anybody he wishes to work with, to collaborate with, versus some kind of security that a company must maintain, and finally, just the general question of how a scientist allocates his time on campus.

At DNA Science we have been trying to address these questions, and let me just end on the note that we have been finding some solutions to these answers and we are confident that solutions will continue to be found to the mutual satisfaction of both industry and university representatives, and ultimately to the satisfaction of society.

Thank you.

[The prepared statement of Dr. Harsanyi follows:]

STATEMENT OF ZSOLT HARSANYI, VICE PRESIDENT, DNA SCIENCE, INC.

Mr. Chairman, Members of the Subcommittee, I am very pleased to be here today to offer my views on university-industry interactions in Biomedical research. I am particularly pleased because prior to my current position as Vice President to DNA Science, Inc., I served as the Project Director for the Congress' own Office of Technology Assessment. My perspective therefore is based on my two years of analysis at the OTA, as well as on my previous 10 years on the faculty of the Cornell University Medical College.

Several decades of basic and somewhat esoteric university research have been responsible for catapulting biology into the limelight. Biology, and genetics, in particular, have become recognized as valuable tools for solving many of society's problems: from developing increased food and energy supplies to providing new medical therapeutics to allowing novel methods of pollution control. Like its sister sciences chemistry and physics, biology has come of age. Biology is taking its place among the technologies as the neologism "Biotechnology" indicates. But the transition from the recognition of biology as a valuable industrial tool to its implementation has been extraordinarily rapid. As a result, justifiable societal concerns have arisen.

One of these, the subject of these hearings, centers on the university. It is here that almost all of the research has been carried out, and it is here that most of the

expertise lies. There are several reasons for this:

- o Many scientists do not want to leave the university. The reasons range from a general contentment with the campus environment to compelling situations of tenure. Some scientists simply don't want to take the risk of leaving those surroundings with which they are familiar. In addition, the fact that industrial interest evolved so rapidly simply hasn't allowed scientists to make the transition. After all, the elapsed time between the first cloning of the rat insulin gene to the production and clinical trials of human insulin made by recombinant DNA was only four years.
- o As we found during the OTA study, much of the success of applying biology to societal problems depends on interdisciplinary research. Collaborative efforts must be established between biochemists, microbiologists, immunologists, enzymologists, organic chemists, pharmacologists, and geneticists. In certain other applications of biotechnology, such as in enhanced oil recovery, even geologists and ecologists must be brought into the interdisciplinary team. While such a broad range of genuine expertise can be brought together on campus, most companies would find the task difficult.
- o Much of the research in biotechnology cannot clearly be categorized as "basic", as opposed to "applied".

As one of the scientists with which DNA Science, Inc. has been collaborating explained: The research on how the genetic code determines the binding of a certain enzyme to the DNA is about as basic as one can get. At the same time, the elucidation of this question could be of significant industrial value if it increases the efficiency of production. As a result, much research in molecular biology is of interest to both the basic biologist and the industrialist. There is no clear line of demarcation which identifies what research is appropriate for the university or for industry.

The message from all of the foregoing is clear: the universities now have and will continue to have something which industry needs. Universities harbor a reservoir of expertise which industry is compelled to tap. As the OTA study reported, the commercial applications of biology are extremely broad. Hence the value of this university information base extends well beyond the area of biomedical research.

Today, American industry is under greater pressure than ever to innovate. To be successful in the area of biotechnology, it must have access to scientists who currently remain on campus. Two general solutions are apparent.

First, industry can wait until either new scientists are trained or more scientists make the transition completely. The former will take too long; the latter is already

causing problems in certain areas of biotechnology. For example, during the OTA study we found that the need for experts in plant molecular biology is so great that many have already left the campus for industry. One of our own contractors reported that even doctoral students were being wooed. The consequence has been a campus brain drain. And the fear among educators has been that we will lack sufficient good professors to train the next generation of plant molecular biologists.

The second general solution is to find mechanisms to promote the fruitful cooperation between universities and industry. The mechanisms must be sensitive to the needs of both groups: the university scientist's need for independence and desire to follow-up stimulating leads vs. industry's need to be highly goal-directed; the scientist's need for open communication vs. industry's need for patent protection; the scientist's freedom to collaborate with whomever he chooses vs. industry's need to maintain security; and simply the conflicting demands on a university scientist's time.

Over the past several months we have been developing possible solutions to these conflicts. For example, a scientist can be given his right to publish anything he pleases albeit with a short delay. Clearly, if the task were simple, we wouldn't be here today. Yet I feel that solutions can be found to the mutual satisfaction of both groups and the ultimate satisfaction of society.

Mr. WALGREN [presiding]. We will return to Mr. Schneider.

Mr. SCHNEIDER. Thank you, Mr. Chairman and members of the subcommittee.

I think with my orientation, I am not like many of the prior witnesses who represent universities and so on. I would like to approach the issues earlier in terms of the MGH contracts and the role of how the Government can sit side by side as a grantor and investor in university research and what is the true role or response or repayment that the Government should get from that.

I think it appropriate that, in terms of my background predominantly as a financial analyst, that I look at it from that aspect. I think the major message that I can bring to these hearings is that, given appropriate incentives, our capital market system works. I think the Congress has a real role in not only appropriating funds for biomedical research, but in offering appropriate financial incentives for private companies and investors to invest right alongside the Government on the campus.

For example, thanks to the 1978 change in the capital gains tax rate passed by the Congress, risk capital is being put to work in this country in record amounts by individuals, financial institutions and corporations. In fact, I would conclude that without this explosion in risk capital to fuel the exciting industrial potential that biotechnology offers, quite probably these hearings might not be held since there might be very little interest in or activity in the private sector in seeking out the kinds of financial arrangements with scientists in academia that we are discussing today.

On the other hand, as in possibly every activity that man engages in, the extremes cause the problems. The so-called average or middle ground is usually the best course, and I think, unsurprisingly, we have that situation existing in the questions we are addressing today. I might point out that for years there was little or no interest or financial activity from the private sector in university-based life sciences research, and I think during those periods of time a moderate amount of such support as had occurred several decades ago, prior to the explosion of the Federal funding efforts in these fields, would indeed have been welcomed by all facets in academia and welcomed with open arms.

Today, I believe that such a moderate amount of well positioned and ethically conducted financial support designed to return a financial reward to the investor and also to put the dramatic discoveries in biomedical science to use is also being welcomed and being welcomed in the vast majority of academic circles. I think there can be tremendous benefit to the Government, as well, if it encourages appropriate investment and cooperation between academia and industry.

Let me cite some numbers that I believe are material to this discussion.

As recently as fiscal year 1979, NIH research grants awarded for biomedical research amounted to some \$1.9 billion. These are, of course, direct outlays from the Federal Treasury and include outright project grants, research center grants, and miscellaneous other types of grants. In that same year, by our estimate, there was less than \$100 million in private sector funding into academic centers on a for-profit basis. Thus, the Federal Government was

outspending risk capital on the campus by some 19 to 1, 3 years ago.

In fiscal year 1980, NIH research grants totaled \$2.1 billion, and our estimate is that private sector for-profit development grants increased to a level of \$150 to \$200 million, making the Federal expenditure then a ratio of some 10 to 1.

Mr. WALGREN. I am sorry. There is a vote on the floor of the House. I am sorry we have these interruptions, but we do. We will be very brief in our suspension, 10 minutes at the most.

Mr. SCHNEIDER. Fine.

Mr. WALGREN. If you would wait until we return we would appreciate it.

[Recess.]

Mr. WALGREN. The subcommittee will be in order, and please continue, Mr. Schneider.

Mr. SCHNEIDER. OK. Thank you, Mr. Chairman.

As I had been saying, in fiscal year 1979 the Federal Government was outspending private capital on the campus by some 19 to 1. In fiscal year 1980, NIH research grants totaled \$2.1 billion, and in that year our estimate for private sector for-profit development grants to academia increased to a level of \$150 million to \$200 million, or a Federal expenditure ratio to private spending of some 10 to 1. In the current fiscal year 1981 period, NIH is expending some \$2.28 billion. However, this year there was an explosion in both big company and small company venture investments in this area, and by our estimates we believe that as much as \$400 million to \$500 million is being poured into the campuses by the private sector, bringing the ratio down to some 5 to 1.

It is possible in fiscal year 1982, again with a budgeted small increase in NIH funding to \$2.47 billion, but with another probable large private sector increase to possibly \$600 million to \$700 million, that the ratio will narrow farther. And by 1985, with the combination of further Federal budget tightening and the growing aggressiveness of business development capital and financial risk capital, we may actually approach a 1-to-1 ratio.

We have heard from others on the problems and issues raised in terms of academic activities and its interface with business, so I am not going to discuss any of those issues, but stick again merely to a strict financial analysis.

As a pharmaceutical industry analyst for E. F. Hutton for the past 7 years, I had concluded that a drug company had an effective in-house research program if its growth in revenues approached twice its rate of spending on research. In other words, a 5-year compound growth rate should show for a drug company that spent 10 percent of its sales on research, I would have called it an industry leader in return on research investment if it could grow at 20 percent a year. But these are large, more mature pharmaceutical companies. One might estimate that smaller, more aggressive venture-type companies should be able to grow at least at twice that pace and this level of growth to research is indeed achieved among the smaller electronics and computer companies and also among several smaller companies in the life sciences area.

We might examine the impact on the Treasury by some of these recent levels of expenditures in the light of this.

If one presumes that the true goal of Federal spending on biomedical research is to build a knowledge base for ultimate gains in the health and welfare of our people, the best way that can occur is through new medical products and procedures entering the normal commercial distribution channels. A cure for cancer that cannot be administered to large numbers of cancer sufferers would only remain an interesting laboratory curiosity and it would be frustrating, indeed, if such a boon could not enter the mainstream of medical practice.

In fiscal year 1979, therefore, going back to the numbers I talked about and using normal parameters of return on research investment and corporate tax rates, the \$100 million in private research might have produced \$400 million in revenues or \$100 million in pretax earnings. This would have returned \$50 million in corporate tax dollars to the Treasury, a relatively insignificant amount considering the \$1.9 billion Federal outlay that year. However, in fiscal year 1982, the \$700 million in private expenditures might produce \$2.8 billion in downstream corporate revenues which would yield \$700 million in pretax earnings or \$350 million in direct Federal corporate income tax payments, about 15 percent of the NIH expenditures coming back, in effect.

If we were to achieve a 1-to-1 spending ratio, corporate tax payments on income produced from these areas could be shown to offset as much as 50 percent of the NIH biomedical research budget, and this is only from direct corporate tax payments. Obviously, the return to the Treasury would be much greater if one also adds into the calculation income tax receipts from individuals employed in these businesses, capital gains taxes paid by investors who profited from company successes, balance-of-payments impacts on the export abroad of American-based biomedical products and technology, and so forth.

I believe it is, indeed, possible to construct a financial scenario to show that with some further encouragement by the Congress of private sector financial support alongside the NIH expenditures, that within this decade the NIH budget in these areas might not be viewed as simply a direct outlay but, rather, an investment by the Treasury to get a net positive return to the country on a financial basis. But probably even more important, it would result in the great research advances being made today by the superior scientists who are on the campus and who want to stay on the campus to have their research translated into products and procedures to save the lives that can be saved and offer better health, quicker and more efficiently, to all of us.

Thank you.

[The prepared statement of Mr. Schneider follows:]

STATEMENT OF NELSON M. SCHNEIDER, VICE PRESIDENT, DNA SCIENCE, INC.

Mr. Chairman, Members of the Subcommittee, I think the major message that I can bring to these hearings is a simple commentary that given appropriate incentives, our capital market system works. Thanks to the 1978 change in the capital gains tax rates passed by Congress, risk capital is being put to work in this country in record amounts by individuals, financial institutions and corporations.

In fact, I would conclude that without the explosion in risk capital to fuel the exciting industrial potential that biotechnology offers, these hearings probably would not be being held, since there would be very little interest or activity in the private sector seeking out financial arrangements with scientists in academia.

As in possibly every activity that man engages in, however, the extremes cause the problems; the so-called average or middle-ground is usually the best course. So, too, unsurprisingly, do we have that situation existing in the questions we are addressing today. For years, there was little or no interest or financial activity from the private sector in university-based life sciences research. During those periods of time, a moderate amount of such support -- as had occurred several decades ago prior to the explosion of the Federal funding efforts in these fields -- would have been welcomed with open arms by academia.

Today, I believe that such a moderate amount of well-positioned and ethically-conducted financial support designed to return a financial reward to the investor and to put the

dramatic discoveries in biomedical science to use is also being welcomed in the vast majority of academic circles. And, I think there can be tremendous benefit to the government if it encourages appropriate investment and cooperation between academia and industry.

Let me cite some numbers that I believe are material to this discussion. As recently as FY 1979, NIH research grants awarded for Biomedical research amounted to \$1.9 billion. These are, of course, direct outlays from the Federal treasury and include outright project grants, research center grants and miscellaneous other types of grants. In that same year, by our estimate, there was less than \$100 million in private sector funding into academic centers on a for-profit basis. Thus, the Federal government was outspending risk capital on the campus by some 19 to 1 three years ago.

In FY 1980, NIH research grants totaled \$2.1 billion, and our estimate is that private sector for-profit development grants increased to a level of \$150-200 million, making the Federal expenditure in a ratio of some 10 to 1.

In the current FY 1981 period, NIH is expending some \$2.28 billion. However, this year, there was an explosion in both big-company and small venture company investment in this area. By our estimates, we believe that as much as \$400-500 million is being poured into the campuses by the private sector, bringing the ratio down to some 5 to 1.

It is possible in FY 1982, again with a budgeted small increase in NIH funding to \$2.47 billion, but with another probable private sector increase to possibly \$600-700 million,

that the ratio will narrow further. By 1985, with the combination of further Federal budget tightening and the growing aggressiveness of business development capital and financial risk capital, we may approach a 1 to 1 ratio.

We have heard from others on the problems and issues raised in terms of academic activities and its interface with business, so I am not going to discuss any of those issues again, but merely stick to a strict financial analysis.

As a pharmaceutical industry analyst for E.F. Hutton & Company for the past seven years, I had concluded that a drug company had an effective in-house research program if its growth in revenues approached twice its rate of spending on research. In other words, on a five-year compound growth rate, a drug company that spent 10% of its sales on research would be considered an industry leader if it could grow at 20% a year. Since these are large, more mature pharmaceutical companies, one could estimate that smaller, more aggressive venture type companies should be able to grow at twice that pace. This level of growth to research is indeed achieved among the smaller electronics and computer companies and also several smaller companies in the life sciences area.

We might examine the impact on the Treasury by some of these recent levels of expenditures. If one presumes that the true goal of Federal spending on biomedical research is to build a knowledge base for ultimate gains in the health and welfare of our people, the best way that can occur is through new medical products and procedures entering the normal commercial distribution channels. A cure for cancer that can

not be administered to large numbers of cancer sufferers would only remain an interesting laboratory curiosity -- it would be frustrating indeed if such a boon could not enter the mainstream of medical practice.

In FY 1979, therefore, using normal parameters of return on research investment and using corporate tax rates, the \$100 million in private research might have produced \$400 million in revenues, or \$100 million in pre-tax earnings. This would have returned \$50 million in corporate tax dollars to the Treasury -- a relatively insignificant amount considering the \$1.9 billion Federal outlay that year.

However, in FY 1982, the \$700 million in private expenditures might produce \$2.8 billion in downstream corporate revenues, which would yield \$700 million in pre-tax earnings, or \$350 million in direct Federal tax payments -- or about 15% of the NIH expenditures "coming back" in effect.

If we achieve a 1 to 1 ratio, corporate tax payments on income produced from these areas could be shown to offset as much as 50% of the NIH biomedical research budget. And this is only from direct corporate tax payments; obviously, the return to the Treasury would be much greater if one adds into the calculation income tax receipts from individuals employed, capital gains taxes paid by investors who profited from company successes, balance of payments impacts on the export abroad of American based biomedical products and technology, and so forth. I believe it is possible to construct a financial scenario to show that with some further encouragement by the Congress of private sector financial support alongside of the NIH expendi-

tures, that within this decade, the NIH budget might not be viewed as simply a direct outlay, but rather an investment by the Treasury to get a net positive return to the country on a financial basis. But probably even more important, it would result in the great research advances being made today by the superior scientists who are on the campus, and who want to stay on the campus translated into products and procedures to save the lives that can be saved and offer better health care quicker and more efficiently.

Mr. WALGREN. Thank you, Mr. Schneider.

Let me ask just briefly: As I understand it, there is a developing market for the kinds of products produced by your company. One source, International Resource Development, Inc., estimates that the market for insulin in 1985 would be about \$73 million and the market for interferon would be \$375 million or thereabouts.

Can I ask what projections of profit a company, such as yours, in this field has for the immediate future?

Mr. SCHNEIDER. Let me address that question not necessarily in what our company would look for specifically, but as the drug industry analyst for E. F. Hutton for a fair number of years, I can tell you what normal industry parameters would be, and that is for proprietary, newly developed pharmaceuticals, the industry goal is to earn about 35 to 45 percent of sales into pretax earnings. So if one were to calculate, based on the numbers you gave, you might say on the \$375 million in interferon sales, if those were dosage-form sales in the normal mainstream pharmaceutical distribution system, those companies selling that product might expect to earn about \$150 million before taxes.

In insulin you might look for, on \$73 million, I think was the number you used, might look to earn about \$30 to \$35 million.

Mr. WALGREN. That is based on general proprietary pharmaceutical returns.

Mr. SCHNEIDER. That is correct.

Mr. WALGREN. Are returns from the biomedical industry any different from the general proprietary pharmaceutical company?

Mr. SCHNEIDER. My opinion would be that companies entering into this field with risk capital being put in terms of research, and how much research dollars and how risky it is before one gets a product on the market, that one should anticipate trying to get that kind of a return on products that actually get into the marketplace.

I would say the rule of thumb should probably hold in this field.

Mr. WALGREN. Can you make any comparison between the research commitment necessary to market a product in the pharmaceutical industry versus the nonuniversity biogenetic firm?

Mr. SCHNEIDER. You mean the drug industry spending on their in-house R. & D.?

Mr. WALGREN. Their estimates and how much it costs to develop a new, attractive product.

Mr. SCHNEIDER. I would be guessing that it probably would take more money and higher risk in this field than it would in the more conventional in-house R. & D. Perhaps Les Glick might have some commentary in that area also.

Mr. WALGREN. Dr. Glick?

Dr. GLICK. I would agree with Mr. Schneider. I am not quite sure what that amount of money is. The problem is we are talking about an industry that has never existed before in as sophisticated a sense as we are trying to make it; that is, there are norms, there are standards about the pharmaceutical industry. But we are trying to create a whole new industry overnight, so I think by definition it has to be riskier.

In terms of the capital that has been put into this industry so far, it is very impressive; that is, as far as the amount of money for very few sales so far. There has been very little activity. There are no products out yet. That is extraordinary. I think there are going to be a lot of business failures in this industry. I would say well over 90 percent.

Mr. WALGREN. Other reactions? Mr. Eggers?

Mr. EGGERS. I keep coming back to the timeframe, which I think is peculiarly misinterpreted by many people these days as the attempt to put numbers on this industry. If you are looking for concrete projects coming out of genetic engineering and biotechnology, it is generally limited to the smallness of man's mind, and they can only see synthetic insulin, perhaps human growth hormones, perhaps some very specific synthetic vaccines, and then the name of the game becomes, "Can you put numbers and prices and quantities and volumes on that relatively short timeframe?"

I find it more exciting and I would think more true to use the longer timeframe. For example, let us say that the pharmaceutical industry worldwide is worth roughly \$40 billion in sales in 1979, I will use very simple arithmetic. If the pharmaceutical industry can grow 10 percent a year, it will double every 7 years, so if you do that 3 times that is 21 years, in the year 2000 you will have a pharmaceutical industry, if my arithmetic is correct, of something like \$160 billion. I was doing that in real dollars.

Make the assumption that one-third of those sales will basically come through genetic engineering and other new techniques that grow out of modern molecular biology and you are not talking small change; you are talking \$50 billion to \$60 billion, and that is only in the pharmaceutical industry.

So again, I agree with Dr. Glick that there is going to be a high casualty rate among companies but a high success rate in the science, but that the arithmetic that should be done has to stretch out at least 10 to 15 years, particularly in matters of framing public policy or, in effect, trying to change the institutional framework of the industry.

Mr. WALGREN. If you compare the pharmaceutical industry with the biotechnology sector, would you find a much greater university-related assist in the biotechnology area than you would in the pharmaceutical area?

Mr. EGGERS. I think so. I will put it another way, which won't make me any friends among my pharmaceutical colleagues.

If you were to identify the 25 leading molecular biologists working today, I doubt that any of them work for the pharmaceutical industry. They all work on campus or in a research institution. There might be one or possibly two company scientists who are batting in a first-class league, but they would strain to make it.

Pharmaceutical companies spend a lot on research, but it is generally applied research. A lot of it is custodial to maintain, the support for their existing products. Their amount of research, basic research, is generally 10 percent of what they spend, and that is not all directed these days to recombinant DNA.

Mr. WALGREN. Then if there is this difference between the pharmaceutical and the biotechnological industries with respect to their relationship with the universities in the process of development, should there be different models of investment for the two industries and the university?

Mr. EGGERS. I believe that new mechanisms are needed. I use the term "joint venture." Everybody uses a joint venture until they try to do one. The hard fact of business life is that lawyers hate joint ventures. They are messy. Big companies don't like joint ventures because they lose control. Professional managers don't like joint ventures because they lose their autonomy. And generally speaking, universities don't like joint ventures because they embody in a very concrete way a lot of the fears that are embedded in the scientific psyche.

Having said that, I still believe that this tremendous revolution that is going on will bring forth new mechanisms that one way or another involve joint ventures that will be perceived to have risk—I don't mean financial risk, but the risk of changing the culture of the company or university that participates in them. The old arms' length licensing relationship, which is good, it has been tested by law, it is based on patents, it has been around, people trust it, is no longer adequate. It is particularly not adequate to the scientist. From a psychic point of view, I believe one of our speakers earlier today said it is not so much the financial reward, but it is the participation, the psychic reward of staying in a little longer in the development process in the commercialization of technology that appeals to the scientist. In the past he has generally been abruptly dropped as soon as his product has spawned a patent and he then goes on and does some more pure research, where there are many scientists who wish to be more participatory in such a thing as an important scientific revolution like genetic engineering.

I believe the more shrewd and sensitive companies will accommodate, if you want, a somewhat new form of participation by the scientist in what was considered a purely business matter in the past.

Mr. WALGREN. Thank you very much, Dr. Glick, you are ready, and I notice the time is getting on and we have more witnesses and I am sure you appreciate that. I am very interested in what you have to say, and if there is any direct way that you can either summarize or excerpt, I am sure that would be helpful, but will you please proceed as you wish?

Dr. GLICK. Thank you, Mr. Chairman.

I will summarize my prepared statement by emphasizing first that the university setting has been the primary setting for basic research. In fact, it is the very nature of the university that allows such research to take place without any immediate practical application in sight. Research takes place for the sake of knowledge; one thing leads to another without any specific black box in mind.

Biotechnology is the summation of a whole series of events that have taken place over the past 30 or 40 years. It has been gaining especial momentum in the past 10 years. Industry is quick to seize the many opportunities afforded by the new technology and to try to develop applications. But the very disquieting factor of universities under severe financial pressure has entered the picture. In the face of declining real government support, universities are looking for new ways to obtain funding. Their main recourse, and the reason for this hearing, lies in new types of commercial relationships. There may be many dangers in that—those who have testified yesterday and today have raised some of these concerns.

I would like to address a point that Mr. Schneider emphasized, in a slightly different way. There are many charges that industry is going to profit unjustly from applications based on basic research done in the universities. This argument is very inaccurate indeed. Industry provides substantial indirect support via taxes on corporate earnings resulting from the applications of new technology. It also improves national economic growth and productivity by applying these technologies to improve existing products, to create new products, and to manufacture older products more efficiently.

An example that comes to mind is the electric calculator. Ten years ago a very simple one without even a memory unit would cost \$500. Today it is 99 percent less expensive.

Over the past few years, we at Genex have undertaken extensive, ongoing technology assessment. We project that by the year 2000, worldwide bulk sales of products whose manufacture will have been affected by recombinant DNA technology will result in a return to the public of \$4.7 billion. This figure combines cost savings to the public on current product lines of about \$2.4 billion and increased taxes due to market growth of about \$2.3 billion.

As I have mentioned, there has been increasing real financial pressure at the university as Federal support of a biological sciences research declines. Consequently the universities are trying to enter into a number of different relationships with industry. I would like, at this point, to summarize four different levels of effort.

The first level is one that has been seen historically. It is not new to biotechnology. The interaction is that of an individual faculty member serving as consultant to industry. This type of interaction works very well for both academia and industry. It permits each side to speak to the other: it permits industry to apply what basic researchers have been doing and permits the basic researchers to get a perspective of what industry has been doing. Such interaction can alter the direction of industrial application—subtly, perhaps, but in a way that can have profound importance.

The second level of interaction stems from university research that results in practical applications. In this case the university typically takes out a patent and licenses the results either exclu-

sively or nonexclusively to various companies. This, too, has been happening for quite a while. The area of biotechnology, however, may point up a number of problems associated with this patenting situation that were not thought of before.

Very recently we at Genex have estimated the number of basic research methodologies involved in designing a new microorganism to produce a new product. Scores of techniques are used—techniques which involve such esoteric things as gene mapping, strain construction, chemical synthesis of short segments of DNA, and perhaps hundreds of modifications of these techniques.

What would have happened in years past had all of these research methodologies been patented? One comes up with two different scenarios. The first is where each of the universities developing these methodologies licensed them on an exclusive basis to individual companies. A patchwork of such licensees would have resulted, with an extensive amount of cross-licensing. The question is: Would this licensing arrangement have made it difficult, if not impossible, to create new microorganisms without infringing on another firm's exclusive license?

The alternative scenario would be where nonexclusive licenses were granted. Suppose a minimum of 50 techniques were involved. Even if the universities licensed their techniques out on a very modest basis, such as one-half of 1 percent—the aggregate is a not-so-modest royalty of 25 percent. This royalty would serve to dampen commercial investment in areas where product demand is elastic; that is, where increases in selling price would dampen the demand for the product. In other situations it would simply dictate that the public pay the added royalty cost; that is, prices would increase to cover the 25 percent.

A third level of university-industry interaction is where industry gives contracts or large grants to universities. We have already heard, today, about Hoechst's \$50 million grant to Massachusetts General Hospital. Research is not restricted under the agreement, and Massachusetts General Hospital personnel can publish freely. Hoechst gets exclusive license to any applications generated by the research.

I, too, ask whether it is justifiable that any of the basic research of a university funded at least in part by public moneys should become the exclusive right—and thus bring profit to—any one or combination of companies. I do not think there is any easy answer to that question. But it is puzzling and it is a problem.

Consider the following situation: Suppose a university had a research budget of several hundred million dollars. If 50 percent of it were funded by large companies, could this interaction eventually change the course of the university's function? Suppose it were 90 percent? I think all here would agree that 90 percent would be too high a level. But what about 10 percent? Dr. Gray testified yesterday that MIT has a 10-percent level. Dr. Kennedy reported that Stanford has less than 5 percent industry contribution to research, with U.S. universities generally averaging 3½ percent. I suppose 3½ percent is all right, but who is to say how high is too high?

A last and very controversial university commercial relationship is that of partnership with its facility members. This final area is

also something that was discussed today. Although Harvard decided not to form a partnership with its faculty in a company, the issues raised remain largely unresolved. Will business dictate to universities? Will business dictate how such a venture should go if such a one were created?

Suppose a professor in such a venture were very good at getting money or at applying research results, not necessarily in a scholarly fashion but in a commercially valuable way. Would this, for instance, have a bearing on whether or not he got tenure? Many questions arise, quite different than those of the scholarly basic research environment.

Academia and industry have different objectives. When university funding declines, there are strong financial pressures, to look for other types of relationships.

I cannot emphasize too strongly the importance of adequate funding of university basic research. Only if there is a strong level of basic research can industry look forward to the future, look forward to many applications where the public can benefit. The university should do what it does best—which is basic research. And industry should do what it does best—which is applied research. The Government has an obligation to adequately fund such basic research because the public will certainly benefit ultimately.

Thank you.

Mr. WALGREN. Thank you very much, Dr. Glick. We appreciate that statement.

[The prepared statement of Dr. Glick follows:]

Statement by J. Leslie Glick, Ph.D.
President, Genex Corporation
June 9, 1981

Subcommittee on Investigations and Oversight
Committee on Science and Technology
United States House of Representatives

Mr. Chairman: I thank you and the Committee for this opportunity to address some of the issues surrounding the commercialization of academic biomedical research. The impacts of such a movement by major universities are far-reaching, affecting not only the university research environment, but, indeed, the future of society.

Universities have historically provided the primary environment for basic research, with private industry implementing the practical applications of this fundamental research. In the face of increasingly reduced real federal support of basic biomedical research programs, however, many universities are contemplating innovative commercial relationships. Yet, the dangers inherent in such new commercial ventures by academia may dictate that universities leave the commercial side to industry. In order to do so and still survive, universities must not be deprived of plentiful governmental support.

Only universities and other research centers provide an atmosphere where research flourishes for the sake of knowledge. This freedom to undertake impractical studies --

those with no foreseeable commercial application -- represents the underpinning of technology. Basic research findings provide the fundamentals necessary to industry's developmental work and exploration. Without basic research, development would dry up; any "breakthrough" -- any technological advance -- is clearly dependent on the accumulation of basic research. The current application of recombinant DNA methodologies by a wide range of industries exemplifies the relationship. Industry is racing to apply accumulated basic research findings to an enormous range of problems in the areas of health, agriculture, energy and the environment. It is surely in the public's best interest to ensure continuing support for basic research. This, in turn, ensures continuing applied research and development leading to new or improved products.

Voluntary agencies, foundations and universities by themselves cannot muster the tremendous resources necessary to support basic research. Industry cannot provide the primary direct support for university basic research without impinging on the independence essential to this research. Government, then, must support university basic research.

Critics commonly charge industry with unjustly profiting on the strength of government-sponsored basic research. This "free-rider" argument is demonstrably incorrect. Industry provides very substantial indirect support for basic research via the income taxes it pays on corporate earnings resulting from its applications of new technology. Industry benefits

national economic growth and productivity by applying the latest technologies to improve existing products, create useful products, and manufacture those products in demand more efficiently, thereby resulting in real cost savings to the consumer. For example, electronic calculators that cost \$500.00 in 1970 cost only \$5.00 in 1980.

Genex has studied this issue of financial return to the public in depth in the case of recombinant DNA technology. Based on an extensive, ongoing, in-house technology assessment, we project the financial return to the public in the year 2000 on worldwide bulk sales of products whose manufacture will have been affected by recombinant DNA technology to be \$4.7 billion. This figure combines cost savings on current product lines (\$2.4 billion) and taxes due to market growth (\$2.3 billion). (1)

Unfortunately, in the last ten years we have seen not an increase, but a decline in federal support of biological sciences research. Administration budget requests for "nontargeted" research have called for decreases, in real terms. Harvard University's history illustrates this trend of dwindling federal funding. While federal grants and contracts covered 37.8 percent of departmental operating income in 1967-68, they covered only 25 percent in the late 1970's. During the same

period, endowment income increased to offset inflation, but not to close the gap left by declining government funding. (2)

It is no wonder that universities are seduced by the prospect of lucrative commercial ventures. Widespread attention to the profits to be made in fields opened by recombinant DNA methodologies has raised the issue of who is to profit from the commercial value of the research. Many universities, as well as individual researchers, feel morally entitled to a significant return on the technological advances initiated in their facilities.

In addition to the chronic need for funds and the lure of profits, the worsening relations between universities and federal agencies are encouraging universities to consider new commercial relationships. Increasing restrictions on grants as well as increasing bureaucratic prescriptions inhibit the pursuit of basic research. Grant tenure continues to be a problem. The "roller-coaster" effect of rapid changes in federal funding caused by annual Congressional appropriations biases against long-range, innovative projects.

At present, we see that universities have compelling incentives to experiment with novel commercial relationships. If federal funds continue to decline, universities must inevitably interact more and more with industry. This commercialization of basic research by universities engenders

new stresses and conflicts of interest in academia. The conditions of cooperation must be carefully spelled out. Researchers must develop a set of principles to guide their behavior in the face of unprecedented commercial incentives.

The range of possible university-industry commercial interactions is broad. Individual faculty members have historically served as adjunct consultants to industry. This blending of academic and industrial perspectives and experience works to the benefit of both academia and industry without apparent compromise to either. Academic consultants lend technical expertise to the analysis of projects. Industrialists, in turn, input the practical analytics of industrial application to academic study. The number of individual university researchers with strong ties to industry has increased in recent years.

At a second level of commercial interaction, universities are increasingly attempting to capitalize on patent royalties as a source of income. The work done in the university laboratory is funded, at last in part, by the public. A company wanting access to particular results must negotiate with the university after the research is completed, patented and published. Commercial cooperation follows in the form of licensing agreements.

This patenting arrangement ostensibly stimulates commercial activity. Closer examination reveals that consistent patenting of basic research methodologies by universities might have just

the opposite effect. Using the recombinant DNA field as an example, suppose that universities had consistently patented the basic research methodologies involved in designing microorganisms as they developed. Scores of essential techniques, and their hundreds of modifications, developed in the last four decades -- involving genetic mapping, strain construction and analytics -- build upon one another to give the tools necessary to design microorganisms. Had the various universities patented their respective inventions and granted exclusive licenses to various commercial firms, the techniques would probably have been parcelled out piecemeal. The patchwork licensing arrangement would have made it difficult, if not impossible, to create microorganisms without infringing on another firm's exclusive license.

On the other hand, suppose the various universities had patented their respective inventions and chosen to grant non-exclusive licenses to commercial firms. Even supposing a "modest" one-half of a percent license, a minimum of only fifty techniques that form the so-called recombinant DNA methodology and enable it to be applied would aggregate to a not-so-modest twenty-five percent royalty. Such a substantial royalty would serve to dampen commercial investment entirely where product demand is elastic -- that is, where increases in selling price would dampen the demand for the product. Where product demand is inelastic, the twenty-five percent royalty would simply push prices up to cover its cost. In either case, it would seem a fallacy to assume that patenting

necessarily stimulates investment and commercial activity. Rather, one could argue that research methodologies arising through the expenditure of public funds should be freely available to attain most widespread commercial development and application.

Contracts from industry to academic laboratories represent a third level of university-industry commercial interaction. Under this arrangement, university laboratories commonly work on specific sponsored projects for companies, granting exclusive rights to the results to these companies. Two ethical problems immediately become apparent: the disruption of both freedom in research direction and of information flow. Where industry represents a significant source of the funds for research, it becomes powerful in influencing what research takes place. Where industrial secrecy necessitated by market competition interrupts the free exchange of information, it has disrupted the very business of universities -- that is, the dissemination of knowledge.

Large generic contracts -- perhaps more appropriately called grants -- are becoming common as a new pattern of commercial interaction. In the most recent case, the Hoechst chemical company of West Germany has given a \$50 million grant to Massachusetts General Hospital. "Under the agreement, the corporation will not control, or keep confidential, research in the new department. The hospital will keep any patents

generated by the research, but will grant exclusive licenses to use them to Hoechst."(3)

One can immediately ask whether it is justifiable that any part of the basic research of a university, funded at least in part by public monies, become the exclusive right -- and thus bring profit to -- any one or combination of companies. Integrity dictates that research methodologies supported in any part by the government be freely available to the public.

A last and very controversial university commercial relationship is that of partnership with its faculty members. Many universities are debating whether to establish a partnership in the recombinant DNA area. The recent proposal by Harvard University to form a partnership between the University and members of the faculty is the most publicized of these proposals. The key element to the partnership in these cases is the licensing to the company of the patents of its professors. While Harvard decided against such a business venture after some debate, the issues raised remain largely unresolved. Harvard University President Bok noted: "It is possible...that the participation of Harvard and its professors in commercial ventures can be structured in ways that are wholly consistent with its academic values...I therefore believe that the University should continue to consider various means of participating in ventures of this kind."(4)

Examination of the the various conflicts of academic and commercial interests spawned by such a partnership makes its formation untenable. The issue of freedom in research direction crops up again: where business interacts with universities, industry is likely to dictate research in profitable rather than scholarly directions. The company's goal of running a profitable company conflicts with the university's mandate to pursue basic science without dictum of commercial application. Any joint venture, then, might stifle independent research.

The juxtaposition of academic and commercial interests reveals, also, lethal stresses on the freedom of information flow. Where business interacts with universities, commercial desire to protect trade secrets will encroach upon researchers' responsibility to circulate research findings. This problem would seem likely to be of a magnitude to significantly reduce access to the body of research work in molecular genetics.

Essentially, the ethical problem confronting a university that enters into a commercial partnership with its faculty members is that financial interests will alter basic research priorities. Industrial organizations are intent on getting out new products, and so bypass long-range basic research activities. In addition to this time-frame difference between universities and industry, there are differences in the measurement of success of research work. While the knowledge gained

throughout a project is the prize in academia, industry faces a harsher "can we now produce economically" judgment. Not only will commercial considerations influence decisions about thesis topics and research proposals, but they will likely also influence the employment and promotion of professors.

We have seen that the commercialization of academic biomedical research is fraught with potential hazards. The benefit to the public of a strong basic research program is indescribable. Basic research has served as the impetus to technological advances that have consistently increased the standard of living and will continue to do so. In the case of biotechnology, the potential applications currently under exploration -- renewable energy resources, more plentiful food supplies, much more efficient and less energy-intensive enzyme and fermentation processes to produce basic chemicals, new drugs and medical treatments, more desirable waste treatments -- the list goes on and on -- are things not dreamed of when the preliminary research leading to the development of recombinant DNA methodologies was initiated. We must preserve the system that best encourages basic research efforts in the biological sciences. A strong, government-funded basic research program is important in terms of the future of society.

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Mr. WALGREN. It is an area that seems to appear, to my mind anyway, as presenting a dilemma rather than a solution, at this point. So on behalf of the subcommittee, we just want to thank you for your testimony, your patience in staying with us all this time, and we do appreciate that very much.

We have two more witnesses, the first being Dr. Carl Djerassi. Dr. Djerassi is a professor of biochemistry at Stanford University. I know Dr. Djerassi indirectly, through a friend, Barry Sharpless, who was a post-doctorate student of yours, a number of years ago. I think he was under you. Welcome to the committee, and we would really like to ask you what you make of all this. You have had contact with this kind of problem for years, really before society was faced with it, and we would be very interested in your assessment of the dilemmas and the problems that will arise in the future.

STATEMENT OF DR. CARL DJERASSI, PROFESSOR OF ORGANIC CHEMISTRY, STANFORD UNIVERSITY

Dr. DJERASSI. Mr. Chairman, you have no written record from me, so I have the enormous advantage of being able to talk on almost anything I would like to. I had planned to talk only about one item, but I am very tempted to comment on the remarks of a number of the people that preceded me.

One correction. I am not a professor of biochemistry as listed in your printed agenda, but of organic chemistry. To a chemist, that's an important distinction, particularly since I do not claim any professional competence in the area of genetic engineering.

You invited me originally, I think, for historical reasons, and I think valid historical reasons. One of the first questions the chairman asked in his letter of invitation was, "The participation of academics in commercial ventures has raised concern about whether individuals can wear two hats." I have done so for over two decades. I have led not only a bigamous but I would say a polygamous professional life for at least two decades, in that I have been and am a professor at Stanford University, while at the same time

having been either a major executive or, chief executive, of companies I have formed myself.

I am currently, as you can see in the biographical sketch I gave you, president of a company (Zoecon Corp.) that I helped form 13 years ago. I am on the board of directors of one genetic engineering company, Cetus Corp. It's the oldest and perhaps largest one, and I'm the only outside director on that board. My involvement has been one of keeping them more down to earth because earlier in my industrial career I have been active in the pharmaceutical industry (Syntex Corp.) for well over 20 years and have had practical experience in that field.

What I would like to demonstrate is that yes, one can wear two hats. Yet one has to be very careful about wearing two or more hats. I think your committee is raising all kinds of questions which are really quite valid ones. I'm afraid, that like in many other congressional hearings, you want black and white answers to grey questions. In the present instance you are posing a fundamentally grey question for which you will never have unambiguous answers.

There are certain problems associated with an intimate relationship between academia and industry. There always will be problems with such interaction, but there are also certain advantages. I think we'll have to pick and choose. I believe that the entire matter has been somewhat blown out of proportion because of the enormous hype and publicity that the stock values of some of the newer bioengineering companies have gotten during the past 2 years. I think that bubble will burst very soon, if it isn't already on the way to doing so; it is bursting for various reasons that we can go into later if there is time.

Let me illustrate how I have tried to solve the "wearing two hats" problem personally, because I am involved or have been involved altogether in the founding or running of three companies on the Stanford Industrial Park, right next to Stanford University. Stanford is perhaps the university with the most sophisticated and formally organized interaction mechanism between universities and industries. The benefits have been enormous, both to the university and industry. I think it is fair to say that Silicone Valley would not exist—geographically at least, and possibly not even qualitatively elsewhere—if the right combination of circumstances had not happened at Stanford the way they did.

It's a very different situation in the biomedical area primarily because of the human toxicology and the Government regulatory aspects. Perhaps I should first address myself to a comment that I heard just now of a couple of earlier speakers where I disagree, even though I agree with their fundamental conclusions.

For instance, Dr. Harsanyi on page 2 of his testimony says, "As we found during the OTA study, much of the success of applying biology to societal problems depends on interdisciplinary research." He is completely right in this. He then lists various disciplines you need, and concludes "While such a broad range of genuine expertise can be brought together on campus, most companies would find the task difficult."

I reach a diametrically opposite conclusion from 30 years of personal experience and have always done so. The type of multidisciplinary interaction mentioned correctly by Dr. Harsanyi in the

biomedical area has so far been possible only in the pharmaceutical industry and not in the universities. I am saying that as a university professor who has always been interested in interdisciplinary research. Universities have all these disciplines present, but name me just one university where all of these disciplines have been able to interact in the same academic institution. They have not. In fact, when you find interaction between a chemist and, let's say, an immunologist, it's frequently by people who are 3,000 miles away in two different universities rather than the same place. In fact, a first-class university is like an opera house. You have prima donnas and, you know, prima donnas all like to sing their own star roles.

Effective interdisciplinary interaction is one of the key roles that industry has played, especially in the pharmaceutical industry. You should ask the question why is it that no one in this country, no Government institution or private institution, has ever developed a new drug, with the possible exception of some vaccines. Invariably it has been the pharmaceutical industry. That doesn't mean it's ideal. In fact, I don't think it is. But at present these are the facts of life, because the pharmaceutical companies are the only ones who have been able to organize this multidisciplinary activity and fund it.

You have heard all kinds of statements, both here and elsewhere, about the fantastic potential of the genetic engineering industry. Some aspects of genetic engineering do represent a sensational scientific discovery. I think genetic engineering will have a very important impact. It will have an impact on a lot of different disciplines. A lot of different industries will benefit from it. However, I do not believe many of the entrepreneurial companies necessarily will, and by no means to the extent that people are talking about, especially when you focus on the biomedical aspects. I think that's probably the wrong focus, with some very few exceptions, of which insulin is really the exception that proves the rule. Interferon is already in a different category, and so are all the others that get daily newspaper publicity.

When you deal with something that is going to be applied to human beings, then you're talking about a lengthy development process, you're talking about enormous expenditures, you're talking about trying to be responsive to a regulatory process, a Government one, both here and abroad. Because of the financial order of magnitude required nowadays for the formation of any new pharmaceutical company no one can name me one pharmaceutical company that has been formed *de novo* in this country in the last 25 years and been financially successful. The same thing applies to pesticide companies with one exception, which happens to be Zoecon Corp. with which I'm associated and whose success was partly due to its eventual merger with Occidental Petroleum Corp. I know both the costs and risks involved. I am telling you that it would be virtually impossible to do this in the year 1981.

The reason for this dim prognosis is that you're dealing with human experimentation, you're dealing with long-term toxicology. Anyone who thinks that this will become shorter or easier in the future is totally naive. For obvious reasons scientific ones, societal

ones, and governmental pressures you're going to find increased requirement rather than decreased one.

There is not a ghost of a chance that any of these new companies—and many of them have first-class people scientifically—will make it alone as new pharmaceutical companies. An earlier witness was talking about a \$30 to \$40 billion market. I think that it is simply unfair to claim such a figure—perhaps it wasn't meant that way—for the genetic engineering industry. It will simply not have these sales. Genetic engineering methodology will have an impact on those sales, that's quite conceivable. But this will be very indirect.

You might say welding has an enormous impact on automobile manufacture, but surely you're not going to say that, therefore, the welding industry is equated to the automobile industry in terms of sales or actual dollar volume. That is where the earlier testimony is totally misleading.

Next, I would like to address myself to what are the dangers of this interaction between universities and industry. I would say the reason this danger has suddenly gotten so much publicity is because a lot of money is suddenly at stake, particularly in the context of financial rewards to faculty members. That always existed in the past, but not of the order of magnitude that has suddenly occurred here, and particularly not in a community that never before benefited from it, namely, the biologists. Chemists, engineers, to a certain extent even physicists, had encountered this at a lower level than you find now, but that has been very common. Dr. Glick very correctly described all kinds of different mechanisms that have been operating historically and I think they will continue to operate historically.

What has happened now is that the biologists suddenly discovered that they are also in demand. They were not really in demand before to that extent because, in part, their discoveries have not had a real impact on patentable proprietary items. This has now changed, and has changed for various reasons, which I think are probably obvious to you; if not, we can discuss them later.

Second, genetic engineering happens to involve a methodology that potentially is very, very useful. But in my opinion the payoff in terms of human pharmaceutical applications with one or two exceptions, will be far off. Let me say what the two exceptions are. Insulin would be one example, and the other one is in the diagnostic area, because here you're not involved in long-term toxicology. But everything else, starting with interferon and so on, is going to take years and years and years. It will take financial muscle and the expertise and the backup of huge companies. They, of course, are the ones that have now gotten involved in this field. I think this is what you're going to find out in the future. You are going to find out that much of this work will be absorbed or performed by the large companies.

And, Mr. Gore, since you just arrived, let me address myself to the questions you started out with in the beginning. I would have liked to have commented on them. I almost felt like interrupting the speaker from MGH when you questioned him with respect to the Harvard-Hoechst interaction. I think it is worthwhile to discuss the \$50 million contribution by Hoechst to the MGH.

You know, a number of universities probably are drooling with envy at MGH for getting \$50 million. When I think what nonproductive time I spend on preparing research grants addressed to the NIH, for a fraction of that amount of money, with no assurance for long-term research but, at best, for 3 or 4 years, and then having to write grant proposals over again, the beneficial impact that the Hoechst contribution will make (as did the earlier mentioned one by Monsanto to Harvard, or the Exxon one to MIT) will clearly be a very major one.

The fact that Hoechst is a foreign company—a point you addressed yourself to—is I think really quite beside the point. Hoechst is really not a German company. It's a multinational company like many of the American counterparts. Hoechst has hundreds of millions of dollars in sales in this country, just to give an example. You asked about how the French would feel. Hoechst owns the largest French pharmaceutical company lock, stock, and barrel, Roussel-Uclaf. Yet Roussel is operating very independently from Hoechst in that regard. I think in that case you're talking about international companies, and science is totally international. Even the funding is international and the manpower is international, the flow of information is international.

In the context of this interaction between universities and industry, we have often concerned ourselves that restriction of publication and desire for confidentiality will suddenly interrupt the academic process. In fact, the attorney from Harvard addressed himself to this in part but really incompletely. He said yes, it is true that at times academic scientists are also confidential and keep information secret until they publish it because they want to be absolutely sure that the work they're doing is correct.

That statement is true of everyone. That is true of academic and of industrial scientists. You do not publish or talk about it in general until you are sure about it. There is plenty of other secrecy and confidentiality in academic life. I have been part-and-parcel of it for so many years that I am quite aware of it. I know it of colleagues in my institution and in many other institutions in my field and other fields. Particularly if you're in a competitive field, the desire to be first—which is an overriding one in scientific research, perhaps unfortunately so, but realistically so—is such that the hotter the field, the less likely it is that people want to talk openly about it until they're sure of the results and until they send it in for publication, because there the name of the game is who publishes first.

These considerations also apply to scientists in industry, particularly the pharmaceutical industry. The publication record of the pharmaceutical industry is superior to that of any other industrial segment. I can give you an example of one I helped found and was associated with until 1972, namely Syntex. Syntex, in the steroid field, which was the field we worked in, published in a period of 10 years more in that field than any other academic institution—academic, gentlemen, not just industrial—and as a result many other competitors found themselves also required to publish.

Take the genetic engineering field. Take Genentech, for instance, a company that has done some very interesting and very exciting research. They publish it all the time. So in this case you're finding

industrial people in a competitive field, of course, also publish promptly.

Furthermore, in the biotechnology area, you cannot keep product information secret because you're usually dealing with eventual clinical work. In pharmaceutical applications you're dealing invariably with projects that you cannot keep secret very long. So any clinical application, ipso facto, will come out to the public very quickly.

You have concerned yourself with patents. Remember that patents are really a form of disseminating knowledge very quickly to the public. Thus you will find countries like Belgium and South Africa that publish patents instantaneously and therefore provide information right away to everyone who reads these. Frequently academicians do not read such patents, but industrialists search Belgian and South African patents continuously to find out what the competition is working on. This is a more open situation, than I think, you're really aware of.

I believe the greatest advantage of collaboration between universities and industry is that it shortens the development process. All of us have a tendency to underestimate what it takes in terms of time, ingenuity, real science, and of course particularly money, to convert a basic research laboratory discovery into something that millions of people can use, particularly when it impinges humans, meaning the toxicological context.

One takes such enormous risks in such work that very few enterprises are prepared to consummate such work and have the wherewithal to do so. It's for that reason that one requires some type of proprietary or exclusive position. That perhaps might be the last point I will address myself to, one that Mr. Gore asked of the Harvard witnesses.

You were very much concerned about the situation with respect to exclusive licenses between Hoechst and MGH. I think you were concerned about it not just because it was a German or foreign company, but because of the exclusivity feature.

We are very peculiar in the United States, in that we have what I would almost call a populist hangup, that if the taxpayer pays for something, it should be completely open and there should be no single group or group of entities, that should benefit from such financial support. It is interesting that our major industrial competitors, Japan and Germany, take the opposite view. In fact, it's noteworthy that companies like Hoechst are the beneficiaries of such benevolent policy. The German Government has specifically supported—not through contracts, but through outright grants—large companies such as Hoechst to support the performance of research in certain areas without even asking for any rights back, giving the companies the eventual patent exclusivity. Japan has done exactly the same thing with some of their companies. The justification for such support is that, if they are successful with this risk capital—this obviously is paid in areas in which the companies themselves would not do so, but where they have some competence—financial returns to the taxpayer would indirectly flow back many times over, through increased employment, through exports, through tax benefits, and so on.

We Americans have felt very strongly the other way around. Yet I think that you are quite familiar with the fact that the U.S. Government did a major study a couple of years ago asking why the U.S. Government owns so many patents and yet little happens with their eventual commercialization. The reason for it, of course, is that the Government owned the patent and would not give an exclusive position to anyone else, and people are not willing to invest the additional risk capital—which frequently is many times what you pay for basic research—in order to bring something to commercial fruition.

This has changed, and this is one of the reasons why NIH has—I forget how many years ago it was, maybe 10 years ago or so—started a system of institutional patent agreements with different universities, to which, for instance, Harvard quite correctly referred. Such institutional patent agreements give the university a right to arrange for exclusive licenses.

My own institution, Stanford University, does precisely this. They do it in the context of being assured that the royalties come back largely to the university, to a certain extent sometimes to the inventors, and that some one is willing to invest a huge amount of money and time and effort, to convert the basic discovery into something practical. So it's a totally precedented situation that a large company, even though foreign, came to Harvard. It's very simple: They wanted to benefit from the academic climate here, and it seems to be short-sighted that more American firms have not been willing to do this on such a scale. I would suspect that this will catch on, perhaps not to the tune of \$50 million per institution per company, but I think it will catch on.

My last point. How did I solve my own problem of potential conflict of interest wearing two hats? I have solved it in a way that I'm not necessarily saying is a recipe for others. I'm not making a value judgment for others. But I decided way back when I proceeded with this bigamous professional nature—incidentally, I first worked in industry and then went to a university, which is the reverse process of what you seem to be concerned about—that I will never work in my academic research on a topic that is of relevance to my industrial connection.

Now, I have made this an inviolate rule. I have never accepted money from the industrial organization with which I was involved for research I'm doing at the university. The research I am doing at the university is supported financially by government and other grants and it is invariably from my industrial interests. I have well over a hundred patents in my industrial career and before I became a professor, as well as several hundred scientific publications. I have not filed a single patent since I became a professor, even though I also wear an industrial hat. But this happens to be my own value judgment and that happens to be the way I have operated. I am not suggesting that other people should do so necessarily. But I am saying it is possible to separate one's possible conflict of interest if you are careful.

I believe, as a result of that bigamous life, I am a very much better and more interesting professor. In addition to everything else I do as a professor at Stanford, I have been able to teach certain policy courses which few other professors have been able to

do as effectively because I have lived in both worlds simultaneously.

I think I'm also a more interesting industrialist. Certainly I know more about basic research, about the gambles that are involved in it, but I'm also really at the frontier of the sciences that interest me. Finally, I happen to combine this with a certain entrepreneurship, and I think there are more and more professors interested in this. I think then, even though there certainly are disadvantages associated with this, that ultimately it's to the good of the public.

Let me cite just one personal example. In the early 1960's, the Stanford Industrial Park, with all the computer and electronic companies, had no biomedical company of any sort. When I moved to Stanford in 1960, I convinced Syntex with whom I had been associated within 2 or 3 years to move from Mexico to Palo Alto. It is now the largest employer, the largest company in the Stanford Industrial Park. Syntex has now exceeded the level of \$500 million. That was a company of \$5 million in the biomedical area when they moved to Palo Alto. As a result of this move, there are now four other companies in the Stanford Industrial Park which in one way or another are offsprings of Syntex.

Except for the fact that I am perhaps directly responsible for a horrible amount of additional commuter traffic, which would not have occurred at Stanford if these companies had not established themselves there, there is no question—in the context of the tax base and the context of benefits for the university—that it has gotten major support from these new industries. It has also had a major impact in terms of employment opportunities for graduate students, postdoctoral fellows, and even faculty members.

Thank you.

Mr. WALGREN. Thank you very much, Dr. Djerassi. We appreciate that.

Mr. Gore?

Mr. GORE. Well, I appreciated your statement. It was very helpful.

You talked about the Hoechst case. We often hear genetic engineering in the context of new industrial revolution, and you referred to several overblown descriptions of it. The fact is, we don't know what its potential really is, but the majority opinion seems to be that it is going to play a very significant role in the future.

Here in the Congress we have been wrapped up in a debate about productivity and what policies the Government can pursue in order to assist American industry to improve its productivity and to improve the productivity of the entire country. That debate often shifts to attention on new and emerging areas where the biggest gains are likely to occur, and many participants in the debate are concerned that the U.S. position itself will take advantage of these new developments. The communications industry is one that is often cited, computers, and there's a lot of concern about the progress of the Japanese in the development of chip capacity and so forth. And another area is genetic engineering.

Indeed, one of the justifications offered—not the principal one I rely on—but one of the justifications offered for the high level support for research at universities in the United States is that it

increases the technological base, or the research base, the data base, and helps position the United States to take advantage of new developments in this area. I think there are a lot of other reasons for supporting it, but nevertheless that's one offered.

It is in that context that I think the relationship announced between Mass General and Hoechst is one that calls into question the flow of benefits involved. I understand your view, and I understand the fact that it is a multi-national corporation. But nationalism still exists, and in fashioning policies in this country we make reference to it regularly.

Dr. DJERASSI. Oh, I don't question that at all. In fact, I am reasonably nationalistic along these lines. As you can judge from my accent, I was not born here, but I am very grateful for the opportunity this country has provided me and I would certainly favor things that would happen in the United States without any question. But that particular aspect of the Hoechst and MGH agreement is not one that really concerns me in that respect.

To address myself to the first part of your question, I completely agree that genetic engineering and the associated methodology is a fantastic advance and will have enormous impacts on many industrial and commercial endeavors, many of which we haven't even anticipated. I do not believe they will occur as soon in the medical area as many people claim. And I am segregating the question of diagnostics. When you are talking about applications to humans, I believe that ultimately they will be very large, but if you're talking about the next decade, and perhaps even more than the next decade, it is unlikely that anyone will make much money, particularly out of the pharmaceutical ramifications of this, with the exception, I repeat, of insulin. That is clearly, in my opinion, the case for this decade. I'm willing to bet an awful lot of money with almost anyone on this.

Mr. GORE. I think you could probably outbet anybody in the room. [Laughter.]

Dr. DJERASSI. That is conceivable.

But that is very different with other applications of genetic engineering; you have heard about some of these. For instance, this applies to enzymatic processes, that would take the place of many standard chemical processes, and where we're not dealing with toxicological questions. I can give you an example only because I happen to be familiar with it through my involvement with Cetus Corp., who are working on a process for producing fructose as an alternative to sugar as a sweetener. Now, fructose is a naturally occurring compound and the commercial implications could be enormous. Here you're talking about billion dollar markets. Another example from Cetus's bioengineering research is the oxidation of hydrocarbons. This is something which again is done on a hundreds of million pound scale. You're talking here about industrial processes, and there are many of this type.

I think you're going to be talking about detoxification of waste material and things like this. You can even talk about the mineral industry. These are all applications where you are independent of regulatory questions, independent of toxicological questions, except for possibly the micro-organisms you might be using, and where the development time is dependent primarily on the financial and

manpower input rather than certain other factors which are outside your own control, which frequently is true in the regulatory process with respect to toxicology.

So I would say the prospects are superb, but I think they are going to occur in a much broader area than biomedical applications on which you and your witnesses and the newspapers are focusing. The applications are going to be more diffuse, and I do not believe, with a few exceptions, that they will benefit enormously many of the smaller companies. But that is really not relevant to the university-industry interaction because I think that, on the whole, the financial interaction has been primarily with larger companies. And even the smaller companies we're referring to, which are the new genetic engineering companies, have been largely funded by large corporate investors and I believe ultimately will probably merge with them in one way or another.

I think you will ultimately find that it's just like in the pharmaceutical field—and I'm not saying it's good; I'm only telling you these are the facts of life—you will end up being centered with a relatively few large companies. Some of them may be new companies, but very few of them will be. I think the majority will be existing ones. I hope and, in fact, believe that the majority of them will be American rather than foreign companies.

Interestingly enough, not just necessarily pharmaceutical companies, but especially the petroleum companies have invested an appreciable amount of venture capital money into this field and would like to get involved in it.

I believe that the single largest amount of money that is being spent right now in the interferon area happens to be by Shell in association with Cetus Corp. It isn't really by one of the pharmaceutical companies, just to give an example.

Mr. GORE. They've got a little extra money, too.

Dr. DJERASSI. Indeed, they do.

Mr. GORE. Thank you very much, and thank you for accepting our invitation to come here today.

Thank you, Mr. Chairman.

Mr. WALGREN. Thank you very much, Dr. Djerassi. We appreciate it.

The last witness is Dr. Quentin Lindsey, science adviser to the Governor of North Carolina.

Would you care to summarize your statement at this point in the day? Welcome to the committee.

STATEMENT OF DR. QUENTIN W. LINDSEY, SCIENCE AND PUBLIC POLICY ADVISER TO THE GOVERNOR OF NORTH CAROLINA

Dr. LINDSEY. Thank you, Mr. Chairman.

Even though last, I appreciate the opportunity to appear before this committee.

In my capacity as science adviser to the Governor of North Carolina, I also serve as a member and executive director of the North Carolina Board of Science and Technology. This board is a 15-member body with the Governor serving as chairman, with 9 distinguished scientists from our research institutions and indus-

try. Four representatives are from State and local government in North Carolina.

In January 1980, the board of science and technology appointed a "Recombinant DNA Committee" for the purpose of outlining steps to be taken by North Carolina to develop a strong molecular biology program.

I have provided committee staff with copies of the recommendations of the board based upon the work of this committee. I will now summarize the content of this document and respond to the questions Congressman Gore raised in his letter inviting me to participate in this hearing.

In making copies of our recommendations available to the committee, I want to stress the fact that we are still exploring many issues and are asking a number of people to review this document and provide us with criticism and suggestions. We have come a long way in deciding what to do, and we expect to take explicit action in July. We therefore welcome any words of wisdom that this committee or others may provide.

The board of science and technology recommends that the State of North Carolina establish a not-for-profit organization identified as the Biotechnology Foundation of North Carolina. The program that the foundation will help foster will have four interrelated components:

First, a unified, outstanding, well-funded program of basic molecular biology research, involving scientists associated with research institutions and firms within the State.

Second, an institutional structure designed to insure appropriate interaction of scientists within the State with each other and with scientists elsewhere; to train and inspire outstanding young scientists; to provide incentives for scientists to do pioneering work of great relevance; and to preserve the integrity of our universities as research and educational institutions.

Third, institutional, financial and other arrangements designed to foster effective industrial utilization of basic scientific discoveries, attract venture capital, encourage entrepreneurs to meet new challenges, and persuade existing firms to locate laboratories and other facilities in North Carolina.

Fourth, appropriate linkages with farmers and farm organizations, medical and pharmaceutical interests, waste management activity, pulp and paper companies, local governments and other constituencies to insure that the nature and purpose of the program are understood and that benefits accrue to such constituencies in an equitable fashion. This component should also insure, as development of all facets of the program takes place, preservation of the quality of our environment and minimization of dangers to human health and well-being.

It is obvious this is a long-run program we are embarking upon.

Now, as to the organization, management, and funding of this foundation, we propose that the governing board of the biotechnology foundation consist of not more than nine members appointed by the Governor. These members shall consist of scientists from our research institutions, together with individuals skilled in business management, industrial development relating to biotechnology, venture capital mobilization, and so on.

We will have a Scientific Review Committee that will be appointed by the chief executive officer, with the concurrence of the board. This committee will guide the research program to insure the maintenance of quality, suggest fruitful lines of research, and stimulate the development of conferences, seminars, and other actions of relevance to developing a strong program in North Carolina.

The board of science and technology will provide initial funding to support the staff of the foundation. The foundation will charge fees of various types in relation to functions performed. The intent is to make the foundation self-supporting within a year or less. The foundation will also solicit general support from other sources through means not construed to be in competition with participating institutions. The National Science Foundation and other private foundations are examples.

Turning to the functions of the foundation, four categories stand out.

First, development of policies and procedures. The foundation will foster joint examination of patents, royalties, licenses, and other existing policies and procedures by participating research institutions within the State. It will also foster appropriate joint meetings between industrial and institutional representatives to examine existing overhead policies and procedures. The intent will be to determine whether changes in patent policies and other matters are desirable, and to determine whether simpler, less costly administrative policies and procedures can be devised, thereby reducing overhead costs and making investment in the research more attractive. Procedures for maintaining various forms and degrees of confidentiality will also be examined.

The foundation will negotiate mutually satisfactory arrangements between industrial firms and research institutions. In doing so, it will perform a variety of brokerage functions. Foundation staff can and will serve in this capacity. Some research institutions may choose to designate industrial liaison officers from among their faculties. In any case, the liaison entails interaction between industrial representatives and research scientists of research institutions.

As the program is formalized, firms that desire to participate in the liaison program will do so for an annual fee. Participation entitles the firm to specified contacts with research scientists at the research institutions, visits by scientists to industry, dialog regarding industrial research needs and opportunities and so on. The result is a working relationship between the research institution and the industrial firm.

Whereas industrial liaison is oriented distinctly toward commercial end results, the foundation will also foster an affiliates program designed primarily to enhance fundamental research among participating institutions. Goals will be more general, however, in this program, with the potential of contributing to essential knowledge, and only in general ways to a variety of end products. Support by industrial firms will be solicited on a fee basis related to size of the firm. Each supporting firm will have access to results of research.

Now, with respect to institutional integrity, it is clear that in fostering the creation of the Biotechnology Foundation, North

Carolina State government is deliberately forming a more explicit partnership with industry and the research institutions of the State, many of which are universities.

Therefore, it is essential that, in forging these relationships, the fundamental purposes of our institutions are preserved. President Bok of Harvard University, as we have heard here today, has spoken of these issues in a recent article in Harvard magazine. An important function of the Biotechnology Foundation of North Carolina thus will be to insure that fundamental institutional purposes are not undermined.

Fundamental developments in molecular biology, as with most basic science, have the potential of beneficial or harmful use. Initial fears relating to molecular biology, however, have been found to be excessive. In the January-February issue of the National Science Foundation publication, "Mosaic," the statement is made that "the questions and worries that triggered Asilomar, Bergetal, congressional hearings, NIH guidelines, public backlash and all, appear to be not only dead but to have been intensified by dizzying successes in recombinant experiments and rapid commercialization of the technology." Nevertheless, still another function of the foundation will be to guide research along positive lines, adhering to established procedures of prudence and safety.

Now let me turn to and address in a general way the questions that Mr. Gore raised in his letter inviting me to appear here.

It should be evident that, as a State, North Carolina is seeking to foster a strong research program in molecular biology. We are concerned with funding, and we are concerned with the nature, quality, and purpose of the program. There are several reasons for this.

First, we believe that it is essential to provide a strong, unified effort that will encompass several of our leading institutions. Second, such action should not place the fund-raising functions exclusively within the institutions themselves. And third, we believe that the brokerage and other functions of the biotechnology foundation we propose to create, if imbued with the importance of equitable sharing of costs, risks, and benefits, and with the maintenance of the integrity of our institutions, will have a strong, positive effect upon the whole operation. Implicit in these reasons is the conviction that costs, risks, and benefits must be shared equitably; that no one component of the partnership of Government, research institution, and industry should be "ripped off" by another.

I do not believe that university-industry "biocommerce" is necessarily a new means for biomedical researchers or any type of research worker to bridge the gap between basic research and development. Most of the procedures we propose to use have been around for a long while. I do believe, however, that the constraints upon public sources of funding for university research, coupled with the commercial potential of biotechnology, provide us with the opportunity to explore more innovative organizational means by which past practices can be put into effect.

It also provides us, in North Carolina, with an opportunity for State government to exercise a more positive role. I believe that there are certain functions that we can perform at the State level

that are difficult for a Federal agency to perform with the degree of detail and institutional commitment that we think possible and necessary.

Your question with respect to whether commercial middlemen or nonprofit foundations can act as buffers against negative institutional impacts of commercialization no doubt pertains to our case. We are obviously following this line of action, as we understand your question.

With respect to a set of guidelines or codes being necessary at the Federal level, I do not believe we are quite ready for such formalization. Our experience suggests that each institution, State, or component of the structure needs to examine its own situation, objectives, and opportunities, and to consider relationships with other components of the potential system.

Such experience needs to be woven into any development of overall guidelines or codes by NIH, IRS, or any other Federal agency. As an interim measure, I suggest that various aspects of this whole process be addressed by a series of conferences to be held over the next several months. We are holding one on patent policy and related matters in the Research Triangle Park of North Carolina on June 18. From such conferences, conclusions can be drawn as to whether it is necessary or not to have Federal codes or guidelines, and if it is, a much better understanding of what is needed will then be available.

Thank you very much for the opportunity to participate.

[The prepared statement of Dr. Lindsey follows:]

REMARKS BEFORE THE COMMITTEE ON SCIENCE AND TECHNOLOGY
SUBCOMMITTEE ON INVESTIGATIONS AND OVERSIGHT
U.S. HOUSE OF REPRESENTATIVES

by

Quentin W. Lindsey, Science and Public Policy Advisor
Office of the Governor, Raleigh, North Carolina

Mr. Chairman and Members of the Committee, I am Quentin W. Lindsey, Science and Public Policy Advisor to James B. Hunt, Jr., Governor of North Carolina. I also serve as member and Executive Director of the North Carolina Board of Science and Technology. This Board is a 15-member body with the Governor serving as Chairman, with nine distinguished scientists from our research institutions, and with four representatives from state and local government in North Carolina.

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THE BIOTECHNOLOGY FOUNDATION OF NORTH CAROLINA

The Board of Science and Technology recommends that the State of North Carolina establish a not-for-profit organization identified as the "Biotechnology Foundation of North Carolina." The program that the Foundation will help foster will have four interrelated components:

1. A unified, outstanding, well-funded program of basic molecular biology research, involving scientists associated with research institutions and firms within the state.
2. An institutional structure designed to (a) ensure appropriate interaction of scientists within the state with each other and with scientists elsewhere, (b) train and inspire outstanding young scientists, and (c) provide incentives for scientists to do pioneering work of great relevance, and (c) preserve the integrity of our universities as research and educational institutions. *off*
3. Institutional, financial and other arrangements designed to foster effective industrial utilization of basic scientific discoveries, attract venture capital, encourage entrepreneurs to meet new challenges, and persuade existing firms to locate laboratories and other facilities in North Carolina.
4. Appropriate linkages with farmers and farm organizations, medical and pharmaceutical interests, waste management activity, pulp and paper companies, local governments and other constituencies to ensure that the nature and purpose of the program are understood and that benefits accrue to such constituencies in an equitable fashion. This component should also ensure, as development of all facets of the program takes place, preservation of the quality of our environment and minimization of dangers to human health and well being.

A. Organization, Management and Funding

1. Governing Board. We propose that the governing board of the Biotechnology Foundation consist of not more than nine members appointed by the Governor. These members shall consist of scientists from our research

institutions, together with individuals skilled in business management, industrial development relating to biotechnology, venture capital mobilization and so on.

2. Scientific Review Committee. The Chief Executive Officer, with the concurrence of the Board, will appoint a Scientific Review Committee to guide the research program, ensure the maintenance of quality, suggest fruitful lines of research, and stimulate the development of conferences, seminars and other actions of relevance to developing a strong program in North Carolina.

3. Funding. The Board of Science and Technology will provide initial funding to support the staff. The Foundation will charge fees of various types in relation to functions performed. The intent is to make the Foundation self-supporting within a year or less. The Foundation will also solicit general support from other sources through means not construed to be in competition with participating institutions. The National Science Foundation and private foundations are examples.

B. Functions of the Foundation. Four categories of functions stand out:

1. Development of Policies and Procedures. The Foundation will foster joint examination of patents, royalties, licenses and other existing policies and procedures by participating institutions. It will also foster appropriate joint meetings between industrial and institutional representatives to examine existing overhead policies and procedures. The intent will be to determine whether changes in patent policies and other matters are desirable, and to determine whether simpler, less costly administrative policies and procedures can be devised, thereby reducing overhead costs and by making investment in this research more attractive. Procedures for maintaining various forms and degrees of confidentiality will also be examined.

2. Brokerage Functions and Affiliates Program. The Foundation will negotiate mutually satisfactory arrangements between industrial firms and research institutions. In doing so, it will perform a variety of brokerage functions. These functions can be enhanced by various forms of industrial liaison. Foundation staff can and will serve in this capacity. Some research institutions may choose to designate industrial liaison officers from among their own faculties. In any case, the liaison entails interaction between industrial representatives and research scientists of research institutions, in the research laboratory and in the industrial plant. As the program is formalized, firms that desire to participate in the liaison program will do so for an annual fee. Participation entitles the firm to specified contacts with research scientists (industrial liaison officers) at the research institutions, visits by scientists to industry, dialogue regarding industrial research needs and opportunities and so on. The result is a working relationship between the research institution and the industrial firm.

Whereas industrial liaison is oriented distinctly toward commercial end-results, the Foundation will foster an Affiliates Program designed primarily to enhance fundamental research among participating institutions. Goals will be more general, with the potential of contributing to essential knowledge, and only in general ways to a variety of end-products. Support by industrial firms will be solicited on a fee basis related to size of firm. Each supporting firm will have access to results of research.

3. Institutional Integrity. It is clear that, in fostering the creation of the Biotechnology Foundation, North Carolina State Government is deliberately forming a more explicit partnership with industry and the research institutions of the State, many of which are universities.

Therefore, it is essential that, in forging these relationships the fundamental purposes of our institutions are preserved. President Bok, of Harvard University, has spoken of these issues in a recent article in Harvard Magazine. An important function of the Biotechnology Foundation of North Carolina thus will be to ensure that fundamental institutional purposes are not undermined.

4. Minimizing Adverse Effects. Fundamental developments in molecular biology, as with most basic science, have the potential of beneficial or harmful use. Initial fears relating to molecular biology, however, have been found to be excessive. In the January-February issue of the National Science Foundation publication, Mosaic, the statement is made (p. 25) that "the questions and worries that triggered Asilomar, Bergetal, congressional hearings, NIH guidelines, public backlash, and all, appear to be not only dead, but to have been intensified by dizzying successes in recombinant experiments and rapid commercialization of the technology." Nevertheless, still another function of the Foundation will be to guide research along positive lines, adhering to established procedures of prudence and safety.

RESPONSE TO THE CHAIRMAN'S QUESTIONS

Turning now to address in a rather general way the questions Chairman Gore raised in his letter to me, it should be evident that, as a state, North Carolina is seeking to foster a strong research program in molecular biology. We are concerned with funding and we are concerned with the nature, quality and purpose of the program. There are several reasons for this. First, we

believe that it is essential to provide a strong unified effort that will encompass several of our leading institutions. Second, such action should not place the fund-raising functions exclusively within the institutions themselves. And third, we believe that the brokerage and other functions of the Biotechnology Foundation we propose to create--if imbued with the importance of equitable sharing of costs, risks and benefits, and with the maintenance of the integrity of our institutions-- will have a strong positive effect upon the operation. Implicit in these reasons is the conviction that costs, risks and benefits must be shared equitably--i.e. that no one component of the partnership of government, research institution and industry should be ripped off by another.

I do not believe that university-industry "biocommerce" is necessarily a new means for biomedical researchers, or any type of research worker, to bridge the gap between basic research and development. Most of the procedures we propose to use have been around for a long while. I do believe, however, that the constraints upon public sources of funding for university research, coupled with the commercial potential of biotechnology, provide us with the opportunity to explore more innovative organizational means by which past practices can be put into effect. It also provides us, in North Carolina, with an opportunity for State Government to exercise a more positive role. I believe that there are certain functions that we can perform at the state level that are difficult for a federal agency to perform with the degree of detail and institutional commitment that we think possible and necessary.

Your question with respect to whether commercial middlemen or nonprofit foundations can act as buffers against negative institutional impacts of commercialization no doubt pertains to our case. We are, obviously, following this line of action, as we understand your question.

With respect to a set of guidelines or codes being necessary, I do not believe we are quite ready for such formalization. Our experience suggests that each institution, state, or other component of the structure needs to examine its own situation, objectives and opportunities, and to consider relationships with other components of the potential system. Such experience needs to be woven into any development of overall guidelines or codes by NIH, IRS or any other federal agency. As an interim measure, I suggest that various aspects of this whole process be addressed by a series of conferences to be held over the next several months. (We are holding one on patent policy and related matters in the Research Triangle Park of North Carolina on June 18.) From such conferences, conclusions can be drawn as to whether it is necessary or not to have federal codes and/or guidelines, and, if it is, a much better understanding of what is needed will then be available.

Thank you very much for the opportunity to participate in this hearing.

Mr. WALGREN. Thank you very much, Dr. Lindsey. We appreciate that statement.

Mr. Gore, anything further?

Mr. GORE. Thank you. I am not going to have many questions. It's been a long 2 days, and I would just like to thank you again for your participation here today.

I think it is very significant that your State has created a biotechnology foundation—

Dr. LINDSEY. We have not yet created it. We're in the process.

Mr. GORE. Well, that you're in the process of creating it. I see that this is a draft of your proposal.

We looked for the State perspective on this issue and asked various experts for assistance in recommending people. I must say I wasn't terribly surprised to find that Governor Hunt of North Carolina is one of the ones who has really taken a lead in this. It is obvious that he has good help in addressing these issues, and I want to compliment you on your very fine and thorough statement here today.

I don't have any questions, Mr. Chairman. I would like to thank you again.

Mr. WALGREN. Thank you.

As we say in the trade, if North Carolina is moving, can Tennessee be far behind. [Laughter.]

Thank you very much, Dr. Lindsey.

[Whereupon, at 5:35 p.m., the joint subcommittees were adjourned.]

